Agency for Toxic Substances and Disease Registry

Division of Health Studies

Big River Mine Tailings Superfund Site Lead Exposure Study

St. Francois County, Missouri

August 1998

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BIG RIVER MINE TAILINGS SUPERFUND SITE
LEAD EXPOSURE STUDY

SUBMITTED BY

MISSOURI DEPARTMENT OF HEALTH
BUREAU OF ENVIRONMENTAL EPIDEMIOLOGY
JEFFERSON CITY, MISSOURI

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DISCLAIMER

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ABSTRACT

The purpose of this study was to determine if living close to the Big River Mine Tailings Superfund Site increased blood lead levels of resident children and what contribution mining waste had to any increase. The average blood lead level of the 226 children in the study group was 6.52 μg/dl compared to 3.43 μg/dl in the 69 control children. The proportion of children with blood lead levels greater than or equal to 10 μg/dl in the study and control groups was 17% and 3%, respectively. Soil and dust lead levels were up to 10 times higher in the study group compared to the control group. Source characterization of lead levels in soil in the study area indicated that approximately 50% of the lead could be determined to originate from mine waste. Approximately 26% of the vacuum dust could be attributed to waste pile source and 37% to soil, of which a proportion probably originated from mine waste.

The results of this study indicated that blood lead levels were a product of exposure to lead mining waste, lead based paint, and other sources. Because the only substantial difference between the study and control areas, in terms of exposure to lead, was the presence of lead mining, mining waste is the most reasonable explanation for the differences between the blood lead levels in the two communities.

BIG RIVER MINE TAILINGS SUPERFUND SITE
LEAD EXPOSURE STUDY

INTRODUCTION

RATIONALE FOR STUDY

A Preliminary Public Health Assessment for the Big River Mine Tailings Superfund Site (considered the "Site" in the text) (Agency for Toxic Substances and Disease Registry, 1994) was reviewed by the Health Activities Recommendation Panel (HARP) at the Agency for Toxic Substances and Disease Registry (ATSDR). It was determined that individuals living on or near this Site were exposed to contaminants at levels of concern. Considering the widespread lead contamination at the Site, the potential for social and personal costs of lead poisoning in children, and the HARP review, the Missouri Department of Health (DOH) proposed to ATSDR to conduct a study of children exposed to lead.

This Site provided an opportunity to evaluate the impact of mine waste, without appreciable waste from smelting operations, on blood lead levels of children living in the area. Two smelting operations located in Bonne Terre operated for less than 10 years around the turn of the century.

In 1995, a report from DOH to ATSDR documented that children living in a Superfund site in Jasper County, Missouri contaminated with lead had significantly higher blood lead levels than children living in a comparison community (ATSDR, 1995). The Jasper County Site was contaminated with waste from lead mining, milling and smelting operations. The smelting operations consisted of primitive lead smelting operations in hundreds of backyard smelters.

RATIONALE FOR LIMITING STUDY TO CHILDREN

Children are at highest risk for lead exposure; therefore, only children six to 90 months of age were selected for this study. This is the age range for considerable hand to mouth behavior. In the Jasper County Study, adults, youths, and children were evaluated. Although blood lead values for all age groups were significantly higher than for a comparison group, only one person in the adult group and one in the youth group had levels greater than 10 micrograms of lead per deciliter of blood (µg/dl) compared to fourteen percent of the children.

Study Objectives

The first overall objective of this study was to determine if living in a former lead mining area increases blood lead levels of resident children. Secondly, if this increase does occur, what contribution did mining waste have to that increase.

BACKGROUND

PROBLEM STATEMENT

Prominent reminders of mining history remain today at the Site with six major tailings piles or ponds, several smaller tailings areas, and numerous closed mines scattered throughout the 110-square-mile Old Lead Belt area (USGS, 1988). In 1990, an assessment of the Big River Mine Tailings site was completed by The Ecology and Environment Field Investigation Team (E&E/FIT) under an EPA contract. Sampled media included air, soil, sediment, and surface and ground water on the Site as well as off the Site. Surface water and sediment were collected from the Big River and tributaries in contact with the mining waste piles. Laboratory results indicated that lead levels found in the pile samples ranged from 910 parts per million (ppm) to 13,000 ppm with a mean concentration of 2,215 ppm. These values represented high concentrations compared with background concentrations (background samples were collected for all media) as low as 64 ppm. These were similar to those reported in a study carried out by the University of Missouri-Rolla (Wixson, 1983). Two residential samples and one near a day care center showed very high lead concentrations similar to those reported from the tailings[1].

E&E/FIT concluded that the Site was affecting the area located to the south. In addition, areas located approximately 1,500 feet from the Site, to the east and southeast, seemed to be the most significantly affected. From this information, it follows that blood lead levels, particularly in children living in the area, should be investigated.

RELATIONSHIP BETWEEN LEAD EXPOSURE, BLOOD LEAD LEVELS, AND HEALTH PROBLEMS

The Centers for Disease Control and Prevention (CDC) considers lead poisoning the number one preventable pediatric health problem facing children today (CDC, 1991). At low levels of exposure, comparable to those found near the Site, several signs of lead toxicity have been described. They include decreased attention span, hyperactivity, and lower IQ scores (Ernhardt et al., 1981). Lead levels as low as 10 μg/dl have been shown to affect child development (Bellinger et al., 1987; Bellinger et al., 1991; Dietrich et al., 1987; Needleman et al., 1990; Ernhart et al., 1986; Lyngbye et al., 1990). Needleman and Gatsonis (1990) report that children's IQ scores are related inversely to low levels of lead burden. Several studies provide sufficient evidence that children's cognition was adversely affected by lead (Bergomi et al., 1989; Ferguson et al., 1988; Fulton et al., 1987; Hansen et al., 1989; Hawk et al., 1986; Hatzakis et al., 1989; Lansdown et al., 1986; Schroeder et al., 1985; Silva et al., 1988 Winneke et al., 1990; Yule et al., 1981).

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[1]*Mining and milling waste can also be referred to as chat or tailings. These terms are used interchangeably throughout the text.*

Adverse effects of lead on intelligence are persistent across socioeconomic strata, as well as different ethnic and racial groups (Baghurst et al., 1992; Dietrich et al., 1993a; Bellinger et al., 1991; Dietrich et al., 1993b). The ATSDR has estimated that among all American children, 17% have blood lead levels above 15 ug/dl (ATSDR, 1988). Among white children, 7% of those with good socioeconomic conditions have elevated lead levels in contrast to 25% in poor whites (ATSDR, 1988). The estimates for black children are 25% among those in good socioeconomic conditions compared with 55% among poor blacks (ATSDR, 1988).

Relevant exposure pathways (i.e. ingestion, inhalation) and sources for children include lead-based paint materials, ambient air, indoor dust, and soil. Lead-based paint is a major contributor to lead poisoning in older homes. Since dust is airborne before it settles, lead particulates in dust are likely to be inhaled. Lead exposure is greatest in indoor dust, where the contaminants are dispersed, trapped, and settled over a confined area (Lepow et al., 1974; Vostal et al., 1974). Few studies are available that indicate how much lead in dust and soil may result in increased blood lead levels when lead is ingested or inhaled (Lepow et al., 1974; Vostal et al., 1974).

People who work in certain hobbies or industries, such as the production of storage batteries; chemical substances, such as paint and gasoline additives; metal products such as sheet lead, solder and pipe, and ammunition, may also be at risk because of exposure at the work place, as well as at home. Potential for contamination of the home environment exists from particulates transferred from work to the household environment (Prior et al., 1994; Klemmer et al., 1975; Knishkowy and Baker, 1986).

EXPOSURE SOURCES RELATED TO THE BIG RIVER MINE TAILINGS SITE

Chat and tailings have been used as fill material or mixed with asphalt as gravel, for road surfacing, and for many other house and garden uses. The material has been spread through the area by man and by erosion. Erosion significantly contributes to down gradient deposition of the contaminated material (Wixson, 1993).

Lead has been detected in private wells at a maximum of 32.9 ppb. Recent monitoring indicates that the level of lead in public water was below the current EPA Action Level of 15 ppb. Lead is naturally occurring in the area, but the deposition of mine tailings at ground surface has made lead more accessible to people. Lead is also a problem in older homes where lead paint has been used. People living near the Site, and tailings throughout the area, have been exposed to lead through incidental ingestion of soils and dust contaminated with lead.

Lead exposure is probably greatest in indoor dust, where the contaminants are trapped, dispersed and settled over a confined area. In the study area, lead has previously been detected at a concentration of 27,460 ppm in the vacuum dust of a home where work with lead products was a hobby (MDOH, 1986). In the same study, lead was found in other homes (with no lead-related hobbies) at a maximum of 5,230 ppm (MDOH, 1986). These concentrations are an indication of the amount of lead in dust that was distributed throughout the households and accessible to the occupants.

Description of Exposure Area

The Big River Mine Tailings Site is located approximately 70 miles south of St. Louis in an area of southeast Missouri known as the "Old Lead Belt". Although lead was discovered in the area in the 1700s, mining was done by individuals as a dispersed, and mostly superficial operation until 1860. At that point, large scale mining was established in the region. Between 1907 and 1953, this area was the major producer of lead in the nation. Mining operations ceased in October, 1972, when the last mine was officially closed (USGS, 1988).

Prominent reminders of the mining history remain today with six major tailings piles or ponds, several smaller tailings areas, and numerous closed mines scattered throughout the 110-square-mile Old Lead Belt area (USGS, 1988). These piles are the result of the stockpiling of tailings. One of these piles is currently listed as a Superfund site. The Site consists of approximately 600 acres of mine tailings in a pile that ranges in height from ground level to more than 100 feet, with an average height of approximately 50 feet. The majority of the Site is situated within a horseshoe-shaped bend of the Big River, which flows on the east, north, and west sides. Residential areas and the city of Desloge are adjacent to the Site on the south and southeast.

In addition to the city of Desloge, the city of Park Hills is also south of the Site and contains three additional tailings piles. A fifth tailings pile (the Bonne Terre pile) is approximately two miles north of the Site in Bonne Terre. A sixth tailings pile, the Leadwood pile, is approximately two miles west of the Site. The piles are shown on a map in Figure 1.

Most of these large piles are located adjacent to residential areas. In some cases, tailings are slumping into existing backyards of adjacent homes. In addition to this deposition in nearby yards, lead-contaminated dust is blown from the piles and redeposited throughout the study area.

A total of approximately 250 million tons of tailings were produced in the Old Lead Belt, with the majority stored in the six major tailings piles (E&E, 1991). The material encountered in the piles and scattered throughout the area consists of small particles ranging from powder to silt and sand. This variety is the result of two methods of separation used for mineral extraction from limestone. Density separation resulted in larger size particulate called chat (approximately the size of fine gravel), and chemical separation resulted in much smaller and fine particulate called tailings (silt/sand type material), which is the predominant form contained in the piles (Wixson et al., 1983).

The piles have been found to have high concentrations of lead. Other metals found in the material include cadmium, arsenic, and zinc. Mine tailings dust containing these metals has been spread into the environment and the surrounding community by wind and rain. Varying concentrations of the heavy metals can be found in environmental media throughout the area including off-site soil, groundwater and surface water, household dust, and in the water, sediment, plants and animals of the Big River.

In late spring 1977, the area received heavy rainfall which caused a large portion of the tailings from the Site to become supersaturated and collapse into the Big River. An estimated

50,000 cubic yards of tailings washed into the river at that time (UMC, 1977). An investigation was initiated by the Environmental Protection Agency (EPA) in response to a concern of the Missouri Department of Natural Resources (MDNR) over pollution of the Big River as a result of the collapse (UMC, 1977). The EPA concluded that the Big River had been degraded as a consequence of physical disturbances in its benthic zone. Chemical toxicity was not reported at that time. The conclusion was based upon aquatic population density and diversity data (EPA, 1991).

Since then, elevated levels of lead, cadmium, arsenic and zinc have been found in plants, crayfish, mussels and fish in the river. As early as 1980, elevated levels of lead detected in fish downstream of the Site were reported by the Missouri Department of Conservation (MDOC). Lead levels in edible fillets ranged from 0.4 ppm to 0.7 ppm (MDOC, 1980). This prompted a news release, issued by the MDOC and the DOH, warning people not to eat fish in the affected area. The DOH issued an advisory against eating bottom feeding fish taken from the 50-mile section of the river between Desloge and the Mammoth Access. The fish advisory is still in effect for bottom feeding fish. The advisory now extends to the Big River's confluence with the Meramec River and sunfish have been added.

The United States Fish and Wildlife Service released the results of their study on the effects of the chat and tailings material on the Big River in 1982. The findings reported elevated heavy metal residues, mainly lead, cadmium, and zinc, in all biologicals examined. Algae, rooted plants, crayfish, mussels, and fish were examined in the study (Schmitt and Finger, 1982).

In 1985, St. Joe Minerals Corporation organized a task force that included representatives of the corporation, MDNR, local officials, and other interested parties. The Desloge Tailings Task Force was in charge of supervision as well as oversight of short and long term stabilization activities on the Site. These activities included seeding and planting black locust trees and settlement of snow fences and have only partially controlled erosion of the piles.

During the same year, the DOH conducted a study of lung cancer in the area. As part of the study, dust was sampled in 46 homes. The average metals concentrations found resembled the concentrations found in the piles. The report concluded that the piles were the major source of lead-contaminated household dust in the area (MDOH, 1986).

METHODS

STUDY DESIGN

In order to ensure that study participants had the greatest likelihood of being exposed to lead contaminants in soil, air, and water media, a study was carried out at the end of summer and early fall

when children were most likely to have spent time outside. Children were located by canvassing the study area to locate eligible participants. Details of this activity are discussed in Section III D. Children qualified for participation if the following applied:

- They were six to 90 months in age; and
- They had been living in the defined study area for at least 60 days prior to the beginning of the study.

A random sample of all homes with eligible children was generated from the study and control areas. If more than one eligible child was available in a home, one child was selected at random from that home. In addition, after exhausting all homes on the initial list without enrolling the required number of children, another random list of remaining eligible homes was drawn. As it happened, we needed to draw several consecutive lists of eligible homes to get enough participants and this resulted in most all eligible homes in the study and control areas being selected.

Two nurses and an environmental specialist were sent to each participant's home that had been included in the sample and whose parents consented to have their child participate in the study. After informed consent, the investigators completed a questionnaire that included information on the child and on the household. A copy of the questionnaire is included in Appendix 1.

A venous blood sample was taken from the child and processed according to the approved protocol (see section III.F.). Environmental samples were collected from the home and yard according to the environmental sampling protocol (see section III.G).

All participant's parents were required to sign a consent to answer the questionnaire and have a venous blood sample taken from their children. Copies of consent forms are included in Appendix 2.

The purpose of the questionnaire was to document demographic, behavioral, occupational, and educational information. Parents were asked to provide questionnaire information for their participant child. Behavior that increases risk of exposure to contaminated environmental media and other possible factors related to lead exposure were documented. Interviewers were trained by DOH staff and by Saint Louis University School of Public Health (SLUSPH). A copy of the questionnaire is included in Appendix 1.

STUDY AREA SELECTION

The study area consisted of Bonne Terre and the area east of Bonne Terre, Desloge, Leadington, Park Hills, Leadwood, Frankclay, Wortham, Mitchell and adjacent areas. Demographic data on these areas from the 1990 U.S. Census are presented in Table 1. These cities are adjacent to the largest mine tailings in the study area (Figure 1).

These towns were chosen for the study because:

I. they presented comparable demographic composition;
II. had high lead levels reported in prior environmental analysis;
III. are located around the largest lead waste piles in the region; and
IV. their proximity to each other.

CONTROL AREA SELECTION

The control group was chosen from Salem, Missouri, an area outside the Old Lead Belt. Salem is 72 miles from the study area. Census data was used to select this area based upon similarities with the study group. Variables from the census data used to make the determination for selection of the control area included: total population, percent of managers or professionals, percent with a high school diploma, percent of families with a child under the age of six, percent of black population under age of six, percent of housing units built before 1960, percent of families with an income below the poverty level, median family income, and median value of owner occupied housing groups.

The selection criteria was to include those zip code areas within the state with a population between 10,000 and 20,000 persons; the zip code areas extend beyond the city limits and therefore do not correspond to the data presented in Table 1. This eliminated all but 75 Missouri zip codes. Percentage of values for the above variables were calculated. The weighted average of these variables was then calculated based on the populations of the zip codes in the study area. This average was used to determine how other zip codes compared with these zip codes by producing an index for each variable. Indices were calculated for each of the above variables. The indexes for each variable were then averaged for each zip code area to obtain an overall index. The overall index was ranked and those zip codes with an overall index value of between 0.95 and 1.05 were kept. All but 18 zip codes were eliminated.

The standard deviation of these variables was also calculated to determine the degree of variation between the variables for each zip code. A zip code could have an extremely low value for one variable and a high value for another that could possibly cause it to have an index of near 1.000. If the standard deviation was less than -0.200, that zip code was included as part of a final list. Six zip codes met these criteria. After examining the location of these zip codes, the city of Salem was chosen because it was the closest to the study area.

Although this area is located outside the mining area, soil and drinking water samples were taken from 10 randomly selected homes prior to the study initiation to ensure that lead levels were not elevated. Levels were considered elevated if the average soil lead levels were greater than background (75-90 ppm) or the average water lead levels were greater than the EPA action level for drinking water (15 ppb). No elevations in lead levels were determined.

Performance of Canvassing Activities

The purpose of the canvass was to identify (from both the study and control areas) all children eligible for participation in the study. Groundwork was laid for the canvass by raising area residents' awareness that it would soon be taking place. This increased awareness was accomplished through media interviews and information releases arranged and provided by the St. Francois County Health Department (Appendix 3). Local law enforcement authorities in both the study and control areas were notified of the canvass activities enabling these agencies to address residents' concerns about the legitimacy of canvassers calling or visiting the homes.

Preceding the canvass, training was conducted for interviewers who would be contacting residents and performing the canvass. The initial training session for canvassers was conducted at the St. Francois County Health Department on March 1, 1995 and included five participants from Mineral Area College, four from SLUSPH, and four from the St. Francois County Health Department. Two additional training sessions were conducted within approximately one month of the first session to expand the size of the canvass workforce. The total number trained included thirty-one students from Mineral Area College (MAC), seven from SLUSPH, and seven from the DOH. All training was conducted by the same individual using the same lecture outline and handouts (Appendix 4). The training sessions included discussion of the following topics:

a) Background information on the study and the purpose of the canvass; General information about the health effects of lead;
b) Description of the study methodology;
c) General description of the canvass; and
d) Detailed description of the canvass form item by item.

The canvass began on March 1, 1995 and was completed on July 30, 1995. A two part approach was used for this canvass including telephone and door-to-door contacts. The information acquired for each home included name, address, phone number, and number of residents age six or younger. Additional information was acquired if there were eligible children in the home. The canvass form used is included as Appendix 5.

The canvass was initiated by phone. After at least four attempts were made to contact a resident by phone, follow-up actions were conducted door-to-door. Phone calls and home visits were made on different days and at different times of the day. A minimum of five attempts, combining telephone and door-to-door visits, were made for each home in the study and control areas.

To aid with the telephone process, a criss-cross directory was utilized. A criss-cross directory provides lists of residents by street with phone numbers providing an effective canvass management tool facilitating the transition from telephone to door-to-door efforts. The criss-cross directory used was produced two years earlier by a local phone company and only covered the study area. Unfortunately, a newer directory was not available and residents of the area are somewhat mobile. Although the dated directory did pose several problems requiring some effort to update the data, it still provided an excellent starting point for the telephone portion of the census.

The problems encountered when accomplishing the canvass of the study area were compounded due to the recent consolidation of the towns of Rivermines, Flat River, Esther, and Elvins into the new township of Park Hills. This resulted in 53 recent street name changes in Park Hills. The adjacent town of Desloge had also recently changed the names of 26 streets in response to the realignment of the surrounding community. This made many homes difficult to locate and some properties difficult to define. The problems introduced by these changes were minimized by the efforts of the St. Francois County Health Department. They updated much of the directory by hand, divided it into manageable sections, and distributed it to the canvassers.

The control area was separated by approximately a one and one-half hour travel time from the study area. Three phone lines were installed at the St. Francois County Health Department with toll free numbers to Salem, MO to facilitate the phone canvass. After several attempts were made by phone to each home in Salem, a team of canvassers traveled to Salem for five days to complete the door-to-door follow-up.

POPULATION SAMPLING STRATEGIES

Study Group Recruitment

All recruitment in the study area was accomplished by telephone contact from the St. Francois County Health Department. The telephone recruitment was preceded by a letter from the local health department explaining the hazards associated with lead and the benefits of participating in the study (Appendix 6). When it became apparent that the population would be exhausted, a newspaper advertisement was placed in the local paper (Appendix 7) to identify interested residents missed during the canvass and those who might have initially declined.

Homes with phones were called at least five times. Those that could not be reached by phone were recruited door-to-door.

Control Group Recruitment

Prior to the initiation of recruitment efforts in the control area, the local law enforcement authorities were notified of the upcoming recruitment. This enabled them to resolve residents' concerns that may have been generated by a study recruiter inquiring about their children. The Dent County Health Department was also notified and provided background information on the study to enable them to thoroughly address questions from concerned callers.

The control area recruitment was initially attempted via telephone by a male representative from SLUSPH. After approximately 20 calls, it was believed that local residents were suspicious of a stranger calling their home and inquiring about their children. The approach was then changed to door-to-door. It was hoped that a personal visit from a recruiter wearing an appropriate identification card would alleviate the suspicions of the residents. This approach did not appear to be substantially

more effective. Approximately 30 eligible homes were visited and consent was acquired from 7 (23%). However, because of the number of homes with eligible children in the comparison area, a consent rate of greater than 50% was needed to gain the desired number of participants.

A factor in this low response rate was thought to be the use of a single, male recruiter visiting homes during the day when many mothers were home alone with their children. Although every effort was made to show the legitimacy of the recruiter with professional apparel and the wearing of visible identification, the reception was still suspicious and often negative. In an effort to resolve this uneasiness, a team was formed of one male and one female representative. Although this did resolve much of the apparent nervousness of the individuals approached, the consent rate was still inadequate, with approximately 30% of contacted homes agreeing to participate in the study.

The feedback obtained from those who refused seemed to indicate a fundamental lack of awareness concerning lead hazards. In an effort to increase their awareness and willingness to participate, a letter was drafted, placed on Dent County Health Department letterhead, and signed by the local health department director. The letter was sent to homes not yet contacted and to homes that had been contacted, but had not yet agreed or refused to participate. It was anticipated that this would not only increase awareness but also reduce the perception that this was an activity being accomplished solely by agencies and organizations outside the community. The letter was somewhat effective; however, the response rate was still not adequate.

In a final attempt to increase the consent rate of those remaining, a secretary from the Dent County Health Department agreed to contact the remaining homes by phone. It was believed that having a local resident make the contact would bring greater legitimacy to the effort, thereby resulting in a more successful recruitment. Since it was apparent that the available control population would be exhausted, an advertisement was placed in the local paper (Appendix 8) soliciting the involvement of any eligible homes in the area. It was hoped that this would identify any homes missed during the census and provide an opportunity for residents who initially declined to reconsider involvement in the study.

Homes were visited at least four times during different days of the week and different times of the day. Also, those with phone numbers were attempted numerous times.

1. Sampling Team Development

   a. Team Composition

There were a total of three primary sampling teams. In addition, there was one back-up sampling team to act as individual substitutes or whole team substitution as the need arose. Each sampling team was comprised of three individuals: an environmental sanitarian, a nurse, and a nurse phlebotomist. Although all team members were cross trained to obtain environmental samples and perform household interviews, only the environmental sanitarian

was trained to use the X-ray Fluorescence Spectrometer (XRF) for direct determination of lead paint concentrations. In addition, only the nurse phlebotomist collected the blood samples. Appendix 9 contains information on team members and responsibilities.

b. Team Training

The first two primary sampling teams and the back-up team attended a two-day in-house seminar (July 19-20, 1995). The training was provided by SLUSPH and DOH staff. Training was provided on overall study protocol and questionnaire administration, environmental sampling protocol for obtaining field samples (soil, water, dust wipes, XRF measurements, floor vacuum and vacuum bags), storage, and chain of custody methods and requirements. A one-day (August 4, 1995) mock field sampling exercise at two homes was performed using the finalized sampling protocols. The third primary sampling team entered the study at a later date and was trained in a similar manner over a two day period (September 20-21, 1995) by the same personnel and two of the primary sampling team members.

c. Team Supervision

During the first two days of field sampling (August 8 - 9, 1995) the primary teams were closely supervised for proper performance of the sampling protocols for blood, environmental measurements and samples, and interview methods by SLUSPH and DOH staff. In addition, the field sampling teams were supervised through periodic visits and observations of sampling practice throughout the sampling period.

BLOOD COLLECTION AND ANALYSIS TECHNIQUES

Venous blood samples were collected from children in the study and comparison groups. The CDC protocol for blood collection and shipment was followed. Samples were analyzed for blood lead levels. The analysis was conducted by the Missouri Department of Health State Public Health Laboratory and the Division of Environmental Health Laboratory Sciences (DEHLS), Centers for Disease Control and Prevention (CDC), Atlanta, Georgia. These laboratories are certified by the National Lead Laboratory Accreditation Program. Protocols for blood collection are included in Appendix 10.

Environmental Sampling and Analysis

Outdoor soil, household soil/dust, drinking water and selected paint samples were collected at the residence of each study and control participant. Painted surfaces inside and outside of each residence that may have been a source of lead exposure to the study population were evaluated for lead content with the use of a portable XRF monitor, a NITON™ XL. Quality control measures practiced during all procedures included: split samples with secondary laboratory analysis, side-by-side sample collection, and submittal of National Institute of Standards and Technology (NIST) Standard Reference Material (SRM) as a blind reference sample. All samples were collected and

stored in pre-labeled and numbered zip-lock 4 mil (0.004 inch thickness) re-sealable plastic bags. All sampling methods, record keeping requirements, forms used, and additional information recorded is described in detail in the "Environmental Sampling Protocol Standard Operation Procedures" in Appendix 11.

1. Sampling Methods, Location, and Rationale

a. Soil

Outdoor soil sampling included up to five, with a minimum of four, composite soil samples collected from each of three locations: (1) the non-play yard area surrounding the house (yard); (2) the area surrounding the foundation of the house (dripline areas within three feet of structure walls); and (3) indicated/designated play areas within the yard. Each sample of a composite consisted of the first one-half inch of normal top soil without vegetation obtained with a slotted 7/8 inch soil recovery probe (HUD, 1993, E-8). Soil samples were taken from up to five (with a minimum of four) sites for each composite. At the time of sampling, the soil condition as to compaction, moistness, and extent of vegetation was assessed and recorded.

Yard area composite soil samples were used to assess environmental sources other than exterior paint that may contain lead. Dripline sampling assessed contributions from exterior lead paint. In addition, it assessed ambient airborne particulate sources that may impact the house structure and wash-off with precipitation. Yard play area samples were used to assess primary outdoor play area exposure sources.

The four main sides of the residence delineated the drip line composite sample area. Where there was a distinct difference in the house exterior structure a fifth side/sample was added. Each sample was collected from approximately the center of each designated side, at least three feet from any visible water run-off area, such as a rain spout, between six and thirty inches from the wall, and, when possible, from a non-vegetated location.

The yard area composite sample areas were also determined by using the natural outlines of the residence to segregate the yard into four main boundary areas by drawing an imaginary line from each corner of the residence to the closest corner boundary of the yard. A fifth area was added when the house and yard configuration warranted. Within each boundary area, a sample was obtained as close to the center of each boundary area as feasible from non-vegetated areas that were not considered play areas, and were at least three feet from a water run-off source.

The yard play area composite samples were obtained from those areas indicated as such by the parent/guardian. Composite samples were collected from as close to the center of each area as feasible, and in a non-vegetated location when available. Sand boxes and other non-soil areas were not included.

In addition to environmental sampling at residences, community play grounds that were indicated by the participants' parents to be main play areas were sampled. Composite soil samples were obtained from five locations within the observed play regions. From visual observation, the observed play areas within each community play ground were divided up to five regions of approximate equal size, as possible. A soil sample was obtained as close to the center of each region as feasible from non-vegetated areas, when available. XRF measurements were performed on playground equipment. These sampling protocols are included in Appendix 11.

b. House Dust

Indoor house dust samples were obtained from three sources: (1) collection of the bag filter within the household vacuum cleaner, when available; (2) a composite vacuum sample taken from up to five one-square foot locations of the household (child's bedroom, main entry area, and up to three play areas) using a modified University of Cincinnati method (HUD, 1992, pp. L10-14); and (3) a composite wipe sample using Wash'n Dri wipes (Millson, et al., 1994; Ashley, 1994) from a measured area of up to five operable window sills randomly selected in the child's bedroom and main play areas (HUD, 1992, pp L15-17). These sampling protocols are included in Appendix 11.

c. Paint

Painted surfaces that had the potential for being a current source of lead exposure were evaluated for lead content with the XRF monitor. Indoors, this included up to a total of four rooms: three rooms indicated as primary play areas and the child's sleeping area. For indoor, outdoor, and detached painted surfaces that were found to contain greater than 0.7 milligrams of lead per square centimeter of area (mg/cm^2), the surface type, physical condition, damage type, potential source of damage, and total and damaged square footage of each painted surface was determined. Paint chip samples for subsequent analysis were only obtained if: a valid XRF reading could not be made; or if XRF readings were ≥ 0.7 mg/cm^2; and a representative paint chip was available from a damaged area (no paint surfaces were to be damaged to obtain a paint chip sample). These paint chip samples were only used to help in determining the source of the lead found in selected dust samples. These sampling protocols are included in Appendix 11.

d. Water

First draw (defined as no water usage within the past 8 hours) kitchen tap water samples were collected. A sample was collected from the kitchen cold water tap into a 250 ml polyethylene bottle (containing nitric acid preservative). These sampling protocols are included in Appendix 11.

2. Sampling Protocol

Environmental samples were obtained at each study site through use of field XRF sampling, dust wipe of window sills, filter vacuum of floors, collection of household vacuum cleaner bag or contents, paint chip samples, drinking water, and soil samples. Field sampling teams also completed forms assessing the characteristics of environmental samples (including condition of lead paint and sample matrices) and an exposure assessment evaluation (See Appendix 11 for field sampling protocols and data collection forms).

The daily field sampling protocol consisted of:

a) Preparation for field work (assuring all needed supplies are present, obtaining addresses, loading vehicles, etc.);
b) Completion of consent forms prior to sampling;
c) Home schematic drawing and determination of indoor sample locations, which included the study child's bedroom, up to three primary play areas, and the main occupant entry. An outdoor schematic indicating the outdoor soil sample areas, and a Global Positioning System (GPS) reading for the study site location;
d) XRF analysis of all painted and varnished surfaces within sample locations, outside wall areas, and detached structures;
e) Collection of paint chips if: no valid XRF result could be obtained, or if XRF readings were ≥ 0.7 mg/cm^2, and if the sample could be obtained without damage to the surface;
f) Window sill wipes of up to five operational windows from the indoor sample sites;
g) Floor filter vacuum of one square foot in each of the indoor sample locations;
h) Separate Composite soil samples from up to five sites each of the house drip line, non-play area yard, play-area yard, and community play areas;
i) Chain-of-custody forms for all collected samples; and,
j) Pre- and post calibration of XRF and vacuum pump used to obtain floor cassette vacuum sample.

SAMPLE ANALYSIS METHODS

The primary laboratory used was TC Analytics located in Norfolk, VA. The laboratory is accredited by the American Industrial Hygiene Association (AIHA) for metals analysis and participates satisfactorily in the EPA Lead Proficiency Analytical Testing (ELPAT) Program for paint chips, soil and dust wipes. Through the Commonwealth of Virginia, Department of General Services, Division of Consolidated Laboratory Services, the laboratory is certified to perform drinking water analysis for lead. The secondary lab used for the preparation of Standard Reference Materials (SRM's) and analysis of duplicate and split samples was Midwest Research Institute (MRI) in Kansas City, MO. MRI is certified by the American Association for Laboratory Accreditation (AALA) under the ELPAT Program for lead in soil, paint chips, dust, air, and drinking water. Laboratory certifications are listed in Appendix 12. Lead analysis was performed using the methodologies in Appendix 13.

Laboratory analysis specifications on instrument method detection limits and instrument practical quantification limits for milligrams of analyte per liter of solution (mg/L), along with the digestion volume, were used to determine the practical quantification limits (PQL) and method detection limits (MDL) for the primary lab reported in Appendix 14. The limits for the secondary laboratory met or exceeded these limits. The MDL's were determined using the procedure outlined in CFR 40, Part 136, Appendix B. The PQL's were considered to be the lowest standard used in the calibration of the instrument. The reported limits take into account the digestion volumes for the samples.

1. Identification of Source Contributions

Source apportionment of lead in house dust, soil, and airborne particles from potentially contributing sources is a difficult task. Determination of source contributions may be affected by many factors, such as similarity of chemical make-up of the lead analyte from different sources, and environmental chemical processes that occur due to solubility and changes in pH leading to chemical degradation and transformations to other lead species during transport and over time.

An automated individual particle analysis (IPA) based on scanning electron microscopy (SEM) and X-ray energy spectroscopy (EDX) was used to assess the potential originating sources of the lead found. These techniques have been shown to be able to discriminate between lead particles at the individual level when bulk sample analysis indicate compositionally similar products (Hunt, et al., 1992). Chemical/elemental morphology and composition is determined through SEM and EDX analysis. Particles with morphologies and elemental associations characteristic of different particulate lead source types can be identified and enumerated. If a classification scheme for IPA results can be developed that provides distinctive "signatures" for the different source type materials, it can be applied to ambient dust samples analyzed under identical conditions, providing a descriptive source apportionment. Based on knowledge of product composition and potential degradation products, groups of particles that most likely are derived from the same source can be probabilistically identified on the basis of morphology and composition.

This method has been used in the United Kingdom as part of a comprehensive study of lead contamination in environmental dusts and as part of a lead contamination study in Australia (Johnson and Hunt, 1994) as well as in studies to determine lead sources near a lead smelter in Missouri (Vander Wood and Brown, 1992). At present, this method generates essentially semi-quantitative results, but should be sufficient for discriminating between lead derived from paint alone or other environmental sources, such as mining waste piles (Johnson and Hunt, 1994). Assessment of the samples for source contribution was performed at the State University of New York, College of Environmental Science and Forestry, Department of Chemistry.

Quality Control Measures

To assure quality control in the environmental sampling and analytical protocols employed, the following methods were used:

1. Use of laboratories with good laboratory practice as evidenced by their accreditation through the AIHA Laboratory Accreditation Program for metal analysis or the AALA (Appendix 12);

2. Use of laboratories participating in the ELPAT program with satisfactory proficiency (Appendix 12);

3. Inter- and intra-laboratory QA/QC results were reported as required under their accreditation programs. The minimum procedures, frequency and criteria for these quality control practices are shown in Appendix 15;

4. Submission of blind NIST SRM samples mixed with the field samples (Appendices 16 and 17). SRM was prepared by the secondary laboratory, MRI, using NIST standards and spiked onto vacuum filter cassettes, dust wipes, water, and soil samples, and submitted to the primary laboratory blindly, along with collected field samples. The sample results obtained from the primary laboratory were submitted to MRI for a QC evaluation and a reporting of the absolute and percent difference. The NIST SRM's used for the spikes are listed in Appendix 16;

5. Submission of field sampling blanks (Appendix 17). Media blanks for vacuum cassette filters, dust wipe media, sample storage containers, and gloves worn during field sampling were submitted and analyzed to assess possible contamination inherent in the sampling protocol, from the presence in the field, or from transport;

6. Preparation and submission of split soil and water samples to a second laboratory for inter-laboratory comparison. Composite soil and water samples were split and one sample submitted to MRI for sample preparation and analysis concentration verification (Appendix 17);

7. To assess variability of the analytes within the soil sample media, a second side-by-side sample was taken for the soil samples within six inches of the first sample (Appendix 17); and

8. All blood lead samples were analyzed by Missouri Department of Health State Public Health Laboratory. Duplicates from 74% of these samples were also analyzed by the DEHLS. The results from the two labs were correlated at r = .97 and an alpha coefficient of reliability of .98. This value indicates a very close agreement between laboratories.

Quality Control for Data Entry

Data was entered into a Microsoft Access Data Base system from the original data collection forms. Quality control was performed through the use of data range delimiters, which would indicate data fields containing improper values such as letters instead of numbers or values outside of allowable ranges; and a random re-check of data entry for 10% of all household files.

Not including the questionnaires, a total of 31 case files (11%) were re-checked for entry error rate from the data collection forms. Each case file contained from 17 to 21 separate forms with approximately 50 entries per form, for an approximate total of 950 entries per case file. A total of 65 entry errors were found and corrected for an error rate of 0.2% per case file, or 0.01% per form. An initial re-check of 20% of the questionnaires (60) was performed for data entry. Each questionnaire contained approximately 150 entries, and demonstrated an error rate of 2.4% per questionnaire. This was found to have resulted from a format error in the data base entry form. After the format error was corrected, an additional 9% (28) questionnaires were rechecked for data entry. A final error rate of 0.1% was found per questionnaire.

Quality Control for Environmental Samples

Entry of environmental sample analysis results were cross referenced with sample numbers on the chain-of-custody forms as the results were received and double checked on entry. Data-base delimiter parameters were used to immediately indicate any values outside of expected value ranges to be re-checked. A 10% quality control check of environmental analysis data entries showed no entry errors. Two soil samples were lost due to inaccurate labeling of sample containers and chain-of-custody forms in the field. Given the number of total environmental samples (over 2,500 excluding blanks, splits and blind reference samples) this resulted in a sample loss rate of less than 0.08%.

In general the quality control results indicated good accuracy, precision, and no interferences. Analysis of field blanks indicated no contamination or interference from the field sampling collection media during field use, shipment, and handling. The analysis of blind reference materials showed good recovery and accuracy by the primary laboratory, with possibly low recovery or loss of sample possible with filter cassettes. The split sample analysis showed good agreement between the primary and secondary laboratory. The side-by-side samples indicated good precision within the primary laboratory, as well as consistency within the soil matrix and compositing procedure.

Appendix 17 shows the frequency of quality control submittals which were achieved. Almost all quality control submission rates were as intended, or exceeded the intended rate. The situations where the achieved rate was less than intended (which were only for field blanks for the gloves and collection bags) were due to chance. The field study sampling was ended prior to the time the field sampling teams would have obtained the last field blank of these items.

Standard Reference Material (Blind Reference)

These samples were inserted into the sampling chain-of-custody protocol in the same manner as field samples to monitor the performance of the laboratory analysis. These samples also provide laboratory analysis analyte recovery information for assessing the accuracy and precision of field sample data through sample preparation and analysis activities. It should be noted, however, that the accuracy and precision achieved for field samples is partially dependent on the matrix matching between the QC sample and field sample since analytical results are generally matrix sensitive. It is not possible to completely match the matrix of the field sample. This is particularly difficult for soil samples; but, the use of split samples as a QC tool helps to compensate for this loss.

A summary of the SRM or Blind Reference sample results are shown in Table 2. Actual concentration values obtained are not shown. Instead, the ratio of the reported lab result to the SRM known concentrations are reported. Descriptive statistics presented include the total number of samples, number of samples reported between the practical quantification limit (PQL) and method detection limit (MDL), number of samples reported below the MDL, minimum, maximum, geometric mean (GM), natural log standard deviation (LNsd), and lower and upper 95% Confidence Limits (CL) for these ratios.

Except for the cassette filter, all ratios of the laboratory value to the reference value for all media were close to one, indicating good recoveries and accuracy in the analysis. In all cases, except for one maximum drinking water and one minimum vacuum cassette sample, the minimum and maximum ratios were within the CL. For drinking water one value exceeded the upper CL by just over 2%. The stability of the drinking water SRM solutions over time was proven through testing of aliquots of stored solution over the sample submittal period (September 1995 through February 1996). The average concentration was found to be 24.26 ug/L with a standard deviation of 0.46 ug/L.

The recovery on the cassette filters had a GM of around 50%, and two of the vacuum cassette samples were well below the lower 95% CL and could be considered outliers. Censoring of these two values as anomalies showed an improved sample recovery response with a GM of around 60%. The poor recovery of sample with the filter cassettes was most likely due to loss of media onto the cassette through static charge and material movement. In addition, the reference material used (Urban particulate) was of a much different consistency than the material collected in the field. It was finer, of more uniform size, and did not contain the organic materials that were collected in field samples. This material was placed on the filter rather than vacuumed, which resulted in a lower adherence. There was no embedding into the surface material that would happen with the field samples. During the transfer of the filter it was much easier to lose the reference type material than the field material. It was expected that the recovery of field samples is greater than for the reference material. A typical accepted tolerance for SRM samples is within 80% to 120% of the true value (percent error of 20%). All SRM summary results, excluding the vacuum cassettes, fell within acceptable ranges.

Field Side-By-Side Samples

Side-by-sides soil samples were included to determine variability due to the sample collection process, and the natural variability due to environmental conditions. Ratios of the paired samples greater/lessor values were determined for analysis. Table 2 reports descriptive statistics that include the number of samples, number of total samples between PQL and MDL, number of samples below MDL, minimum and maximum ratio, GM ratio, LNsd and 95% upper CL.

The inherent variability between field samples was evident in these results. Despite being collected side-by-side (within six inches of each other), a number of pairs were measured to have very different lead contents as reflected in the higher ratios, GM difference of 64%, and relatively large estimated upper 95% CL. The removal of one outlier from the lead sample showed an improved maximum ratio difference of 6.8 and a GM difference of only 39%, with an R-squared of 0.81. These values indicated a relatively good homogeneity within the soil samples obtained and a consistent sampling procedure.

Split (Duplicate) Samples

Split, or duplicate, samples are expected to be relatively similar in analyte content because they are representative samples from a composite field sample collection mixture. One of each of the two samples were sent to the primary and secondary laboratories. The descriptive statistics were the same as generated for the field side-by-side analysis and are summarized in Table 2. Due to variations in compositing and media, a normal tolerance for split sample analysis is 40%. Although the lead analysis for vacuum filter samples was close to the extreme of the range, all GM ratios were within this range. The soil split samples agreed very well, and when three of the soil lead outliers were taken into account, the soil GM ratios of differences were below 30%. The R-squared value for soil lead was 0.89 and for vacuum bag lead was 0.44.

The water split sample ratios were almost 1, with very little range between the minimum and maximum ratios. Almost all water samples were below the PQL, so a meaningful R-squared value could not be determined. Results for soil and water split samples indicated very good agreement between the two labs and were indicative of good accuracy and precision in the sample results.

Field Blanks

Field blanks are identical to regular field samples, except that no sample is actually collected. Field blanks provide information on the extent of contamination experienced through field samples resulting from a combination of laboratory processing and field handling. The field blank samples were analyzed for lead. A summary of the field blank results are presented in Table 2. The descriptive statistics were the same as generated for the SRM. The upper CL was only reported since the reported concentration limits could not go below the MDL. All of the cassette filter and dust wipe results for lead were below the PQL. The largest lead concentration reported for a field blank dust wipe was 13.8 µg. The GM for lead was 4.9 µg. All of the GM for the field blanks were very close to their respective PQL's. Data suggest that no contamination of field samples occurred during the sampling, handling, and field transport activities.

DATA ANALYSIS

Statistical data analysis was performed by SLUSPH. The Statistical Package for Social Sciences (SPSS) was used. The variety of statistical analyses included:

- Comparison of mean blood lead and environmental lead data between the study and control populations by t-test and analysis of covariance;

- Comparison of proportion of children with blood lead levels above 10 μg/dl between the two groups using chi-square analysis;

- Comparison of mean blood lead levels between various risk factor groups by t-test and analysis of variance; and
- Correlation analysis was used to assess the relationship between blood lead levels and a number of environmental variables (soil, dust, paint, water lead, condition of house, etc.), behavioral variables, demographic variables, socio-economic variables, and household characteristics.

RESULTS

CANVASS INFORMATION

The Study and Control areas were somewhat different in dimensions, however, findings indicate they were demographically very similar. A comparison of the study and control area canvass can be seen in Table 3. At least 95% of the homes in each area were contacted by either telephone or home visit. The canvass required a total of 5,937 phone calls with a mean of 1.62 calls needed for those homes successfully contacted by phone and 6,553 home visits with a mean of 1.25 visits needed for those homes successfully contacted by door-to-door visits. This combined approach proved to be effective in meeting the objectives of the canvass. Of the homes successfully contacted by phone, 65% were reached on the first call and 86% by the second. Comparing this to the home visits, 82% of homes successfully contacted by a visit were reached on the first visit and 94% were contacted by the second.

Recruitment Information

The canvass of the study area identified 779 homes eligible for participation in the project. From the 779, 30% participated in the study; 39% refused to participate; 8% canceled their appointments after initially consenting; 11% moved or refused to participate due to an anticipated move; and 2% could not participate for other reasons. Others excluded had children that were not yet six months old or had children who were older than 90 months. In summary, those refusing, canceling, moving, or excluded for other reasons totaled 60% of the homes. There were also 10% of the homes that could not be contacted (Table 3).

The canvass of the control area (Salem, Missouri) identified 249 homes eligible for participation in the project. From the 249, 29% participated in the study; 29% refused to participate; 14% canceled their appointments after initially consenting; 10% moved or refused to participate due to an anticipated move, 10% could not participate for other reasons. In summary, those refusing, canceling, moving, or excluded for other reasons totaled 63% of the homes. Another 8% of the homes could not be contacted (Table 3).

Descriptive Statistics of Study and Control Areas

This study evaluated 235 children from an area of Missouri where lead mining had taken place over the past century (study) and 72 children from an area where lead mining had never taken place (control). The children were between the ages of six and 90 months at the time of sampling except for one child who was 92 months. This child was included because an incorrect date of birth was obtained during the canvass. Since a blood sample had been obtained and the child was only two months over the cutoff date, the child was retained. Statistical analysis was repeated without this child without any effect on mean values.

Figure 2 presents the frequency distribution of blood lead results for the study and control groups. Blood samples could not be obtained from nine children in the study area and three children in the control area. Seventeen percent of the children in the study group had blood lead levels greater than or equal to 10 µg/dl, the level of concern established by the Centers for Disease Control and Prevention (CDC) and 3.5% had levels greater than or equal to 15 µg/dl. Only two children in the study group had levels greater than 20 µg/dl. In the control group, two children had blood lead levels of 10 µg/dl. Remaining blood lead levels were less than 10 µg/dl.

Table 4 presents the responses to the questionnaire administered to a parent or legal guardian of each child. The information was obtained from the mother in approximately 86% of the interviews. Both the study and control groups were of similar age with an overall average age of 3.72 years. Approximately 50% of both groups were female and all except three children in the study group were white. The distribution of household income was similar between the two groups. The distribution of years of education was also similar, except that slightly fewer mothers in the control group finished high school. In the study area, 48% of the homes were built prior to 1960 compared to 32% of the homes in the control area. Significantly more homes in the study area were owner occupied than in the control area, 62.3% versus 45.8%. Plastic pipes were predominant in the study area homes while copper piping was most frequently used in the control area. The source of water for both the study and control groups was almost always from a public water system, however, significantly more children in the study area drank bottled water. Numbers in the tables will not always be the same as the number of children recruited because some measurements could not be made on every child.

Almost half the homes in both areas have had some form of renovation within the past year, particularly in the child's bedroom. Over 20% of the homes in the study area used mining material in the yard compared to 4% in the control area. More often a household member in the study area repaired automobile radiators and worked in auto maintenance. Although a number of household members in both groups worked in occupations or had hobbies that might result in contact with lead,

there were no other differences between the two groups that might result in bringing lead contamination into the home. Few people in either community currently work in a lead mining activity.

Slightly more households in the control community used foreign made clay pottery or ceramic dishes to prepare, serve, or store food or drinks. There were no differences in the use of copper or pewter between groups. Few differences in housecleaning methods or frequency were evident between the two groups, except the study group is more likely to dry dust.

Approximately 50% of the households in both areas had at least one person that used tobacco products in the home. Of those families with children less than two years of age, more children breast feed in the control area. Children spent similar amounts of time playing on the floor in both groups, approximately 5.5 hours per day. Children seemed to play outdoors a little more often in the control area than in the study area and when playing outdoors, they spent more time there. Over 40% of children in both groups had a favorite blanket or toy but study children were less likely to put that item in their mouth. More households in the study area had a vegetable garden in which children were more likely to eat from while control children were more likely to eat vegetables grown elsewhere in local area.

Comparison of Blood Lead and Environmental Factors

Table 5 presents a comparison of mean blood lead levels and environmental data between the study and control groups. The average blood lead values were almost twice as high in the study compared to the control group, 6.52 and 3.43 µg/dl, respectively. There was also significantly more variation in the study group. The concentration of lead found in the vacuum bag was seven times higher in the study area compared to control area. The lead concentration found in the soil of the designated play areas of the study group was over 10 times that for the control area. In both areas, the soil lead at drip line was higher than the average of the yard soil. It is interesting to note that the soil lead levels in the play area were higher than the average for the rest of the yard. All values for lead collected from the floor using the vacuum cassette sampling method were significantly higher in the study area. This was also true of the dust wipe samples taken from the window sill. Indoor XRF reported readings tended to be higher in the study area. Outdoor XRF readings were similar in the two groups. In the study area, 72% of the homes had indoor XRF values greater than zero mg/cm^2 and 55% had values greater than or equal to .7 mg/cm^2. Outdoor areas greater than zero mg/cm^2 occurred in 80% of the homes and 64% of the homes had XRF readings greater than or equal to .7 mg/cm^2 on outdoor surfaces. Water lead levels were slightly higher in the control group, however, this was not statistically significant. Although measures of dustiness of rooms were slightly lower in the study area, the differences were not statistically significant.

Mean blood lead comparisons were repeated correcting for total indoor XRF and total outdoor XRF values because of the differences in XRF values for the study and control homes. This also adjusts for age of house, which differed between the two groups. Age of house correlates with the objective measure of lead paint, XRF. These XRF measures were chosen as covariates because

they had the highest correlation with blood lead levels. The mean values for the study and control groups before correcting for covariates were 6.52 and 3.43 μg/dl and after correction were 6.44 and 3.70 μg/dl, respectively. No other factors were determined to be confounding variables.

BLOOD LEAD COMPARISON ON CATEGORIES FROM QUESTIONNAIRE

Table 6 displays blood lead level comparisons between various categories on the questionnaire. A t-test was used for two category comparisons and analysis of variance was used for multi-category comparisons. Care should be taken when interpreting the data in categories that contain less than five children because the significance level might not be meaningful. It is possible to collapse groupings with multi-category variables that contain few children, however, it was decided to show all categories for the readers information. A one-way analysis of variance was chosen because the purpose of this analysis was to investigate potential confounding variables, not to compare study and control groups.

Blood lead levels for males and females were not significantly different from each other. Within both groups, average blood lead levels decreased with an increase in income but the differences were only statistically significant for the study group. Blood lead levels tended to decrease with increasing levels of education. A comparison between homes built before 1960 and after 1960 showed a significant difference in both the study and control groups, however, the difference was only on average approximately 1 μg/dl. Children who came from homes that were rented tended to have slightly higher blood lead levels than children coming from resident owned homes, however, this difference was only significant for the control group.

In the study group, blood lead levels were similar for children using public water and those using bottled water. The blood lead levels, however, were significantly lower in children using well water for both drinking water and water for cooking, (note, the number of children using well water was quite small). When a family member worked in auto bodies or auto maintenance, children in that household had higher blood lead levels than for children with family members not involved in these occupations. Six family members in the study group indicated that they casted or smelted lead. The children in these families had significantly higher blood lead levels. The few children who were in families with members who recently worked in mining had significantly higher blood lead levels than children from non-mining families. Although there was a significant difference between the categories of dry sweeping, the pattern of differences was not consistent. Children living in homes that always dry sweep have the highest blood lead levels, however, the next highest level is in families who never dry sweep.

Household cigarette smoking is associated with significant higher blood lead levels. There is a very consistent pattern associated with a child playing in dirt. The more frequently that this occurs the higher the blood lead levels. The more often that a child takes food, snacks, or candy outside, the higher their blood lead levels.

Correlational Analysis

Table 7 presents correlation coefficients and significance levels for various environmental factors and questionnaire data correlated with blood lead levels in children in the study area. Table 8 displays this data for the control group. A level of 0.10 was chosen as borderline significance and of potential interest in interpreting the results.

Most environmental measures reported in Table 7 for the study area were significantly correlated with blood lead levels. A number of correlation coefficients were statistically significant for the questionnaire data.

Higher blood lead levels in children were associated with the following:

- Homes using a dry sweep method more often;
- Children who play in dirt more often;
- Children who take food outside more often;
- Children who wash more often before sleeping;
- Children who carry a favorite toy around more often;
- Children who swallow things more often.

Lower blood lead levels were associated with the following:

- Children who wash more often after playing in dirt;
- Children who chew fingernails more often;
- Mothers who have higher education levels;
- Families who spend more on food; and
- Families who have a higher household income.

The only environmental factor for the control group (Table 8) that was significantly correlated to blood lead levels was the lead level of the yard soil. The only significant correlations with questionnaire data were how often the child plays in grassy areas, how often the child plays in dirt, how often a child uses a pacifier, the mother's education level, and the household income.

Table 9 shows correlations between dust and soil lead measures in the study group. The only significant relationship was between soil lead at the drip line and wipe samples of the window sills. Total XRF values were significantly correlated with lead concentrations in vacuum bag, lead concentration in soil at drip line, and dust wipe samples of window sills (Table 10).

In all cases, the correlation coefficients are low and have only limited predictive value. They do suggest relationships between a number of environmental and sociobehavioral factors and blood lead levels that can be utilized in designing an intervention project.

IDENTIFICATION OF SOURCE CONTRIBUTIONS

Individual Particle Analysis (IPA) technique with the use of automated scanning electron microscopy (SEM) coupled with image analysis and X-ray energy spectroscopy was used to:

1. Determine whether particulate lead forms in the mining waste materials in the study area could be distinguished from those of lead-bearing paint origin;

2. Determine a classification scheme to discriminate mining waste particulate from paint; and

3. To estimate the source contributions to the lead present in household dusts.

The results from analysis of samples from five different composites of mining waste piles and twelve paint chip samples were used to develop an algorithm for assessing source contribution. A composite of six study area soil samples, which did not contain paint chip samples, indicated that a classification scheme was possible to separate the results of IPA measured characteristics into source descriptive categories. This classification scheme was used to identify and proportion the relative percent contribution for source of lead found in vacuum bag dust samples for eight selected study area homes. The homes from the study area were selected randomly from homes that were found to contain lead-based paint, as well as lead within yard soil, vacuum bag dust, and window sill wipe samples.

Table 11 indicates the range and median percentages attributed to the source categories of waste pile, paint, soil, or common (could not differentiate with IPA between the possible sources). The common category was based on the presence of lead oxide and lead carbonate that were oxides of lead from which the originating source could not be determined. The formation of the oxides could be from 'weathering' or fine abrasion. The most conservative classification schemes are presented. In addition to the final results for the source contribution to the dust in the home vacuum bags, the application of the developed classification scheme on the waste pile, paint chip and soil composite samples are also shown. The first level of the classification scheme developed weights the percent attributed to a source category based on the volume sum of the particles analyzed and are identified as 'Waste Volume' (WV), 'Paint Volume' (PV), 'Soil Volume' (SV), and 'Common Volume' (CV). The second level additionally weights by the fraction of lead determined in each particle as shown by WVL, PVL, SVL and CVL, respectively. For example, a comparison of WV and WVL for 'Waste Piles' showed that the total volume of particles that were a source of lead and that could be identified as derived from the waste piles was 79.1% of the total particle volume. Inclusion of the fraction of the lead present in the total volume indicated that only 69.4% of the lead measured could be said to have been derived from the waste piles. In other words, for this example, even though the total volume was greatest from the waste piles (79.1%) for particles containing lead, only 69.4% of the total lead measured could be said to have been derived from the waste piles.

Using both the developed classification schemes on known waste pile samples (i.e. samples obtained from the waste piles) a high identification as to the actual source (69.4 - 79.1%) was

observed, versus only a low misclassification as paint (3.4 - 4.7%), and 16.3 - 26.8% of the time the source could not be determined. The classification scheme applied to paint chip samples was more specific in that 82.25 - 85.65% of the identification was made properly as paint, only 0.3 - 0.35% was misclassified as mining waste, and 13.85– 15.85% could not be identified as either waste or paint derived. The application of the classification schemes on the composite soil samples indicated that paint was not a lead source and suggests that the algorithm is not prone to false positive indications for paint. The Soil results further indicate that 48.5 - 51% of the lead is derived from the waste piles while the source of 41.5 - 49.5% of the lead could not be determined.

DISCUSSION

STUDY LIMITATIONS

Although interesting data was obtained from the source characterization, the sample size was small. More study area samples need to be done in the future as well as control samples for comparison.

Only 30% of those homes with children that were contacted agreed to participate. This participation rate limits the generalizability of the results to all children living in the area, however, the participation rate was similar in the study and control areas.

The original proposal planned on a larger number of control participants but this number was not achieved because we depleted all eligible children in the control area. This did not impact on study power. With a sample size for blood lead measurements of 226 in the study group and 69 in the control group, an alpha two tailed at .05, and a difference between means of 3.09 µg/dl, the power was 84%. The power for the proportion of children with blood lead levels of 10 µg/dl or higher was 89%.

We had originally proposed including children between the ages of six and 72 months of age but increased the upper age limit to 90 months. This was done because of the low recruitment rate. Nine percent of the study area children and 12.4% of the control area children were over 72 months of age.

STUDY STRENGTHS

Selection of a control area that was comparable to the study area on a variety of demographic factors enhanced the interpretation of results. An extensive environmental assessment of every home in the study and control area permitted correlational analysis between environmental and blood lead data and the XRF determinations could be used to control for the effects of paint on blood lead levels.

Including source determinations in the project provided additional information that has not been available for any other studies evaluating the relationship between exposure to lead mining

waste and blood lead levels. The results of this study brings into question the results of other lead mining studies that suggested that lead in mining waste was not bioavailable.

One of the more important indirect benefits from this study was that extensive health education efforts have been initiated in the area to reduce exposure to lead. Also, the local health department that participated in the study has evidence that can be used to obtain additional funds to continue lead screening and education efforts in the community. This includes the development of an assessment team to visit homes that have children at risk for lead exposure. The team will also screen the children and inspect the homes for sources of lead exposure.

INTERPRETATION

This study was conducted to determine whether exposure to lead mining waste increases the body burden of lead in children as measured by blood lead levels. Children between the ages of six and 90 months were selected for participation because they were at highest risk for exposure. This is primarily related to their hand-to-mouth behavior and the enhanced uptake of lead from the gastrointestinal tract. It was determined that children living in the Big River lead mining area had average blood lead levels twice as high as children living in a non-mining area, 6.52 µg/dl verses 3.43 µg/dl and that 17% of the study children were lead poisoned as defined by the Center for Disease Control and Prevention guidelines (CDC, 1991) compared to three percent in the control community. This section will discuss these results in terms of pathways, sources, and implications of exposure.

Exposure to lead occurs primarily through ingestion of surface dust and soil. Some children may purposefully swallow non-food items such as paint chips and soil, a condition called pica, but more often, lead is inadvertently ingested by children putting contaminated hands, toys, and food items into their mouths. Soil may enter the house as dust by atmospheric transport and by animals and humans who bring soil indoors on their bodies, clothes, or shoes (ATSDR, 1988). It has been estimated that approximately 30% of household dust is derived from outdoor soil and the remaining 70% from other sources (Calabrese and Stanek, 1992). This is consistent with the source characterization from the present study that found that approximately 30% of the dust lead found in the room originated from soil; however, this percent is probably low because the source for a substantial proportion of the dust could not be determined. Children in the present study were most likely exposed to the mining waste through the indoor dust that contaminates hands and other items and by playing in their yards. Some exposure might also have occurred by inhaling soil and dust, but because of the particle's size, this route was probably of minor importance.

The bioavailabilty of lead in soil (amount of lead absorbed from the gastrointestinal tract), particularly related to soil contaminated with lead mining waste, is poorly understood. Danse et al (1995) recently reported results from 13 former mining communities. Mine waste containing up to 20,000 ppm lead, primarily in the form of lead sulfide (galena), was present. Danse et al found no significant increase in blood lead levels compared to a control population. They concluded that lead as galena was not readily bioavailable. This was consistent with earlier reports of Bornschein et al (1989), the Colorado Department of Health (1990), Steele et al (1990), Woodward-Clyde et al

(1993), and Bjerre et al (1993) that found no relationships between environmental lead from mining operations and blood lead levels. These conclusions have been questioned by Mushak (1991) and Gulson (1994) who argue that many of the reports suggesting the absence of relationships between blood lead and mining waste contaminated soil were based upon historic data of questionable epidemiological quality. Lead in the mine waste from this study was also in the form of lead sulfate and yet the blood lead levels from children exposed to this waste were considerably higher than the control group.

Gulson et al. (1994) reported a positive relationship between lead mine waste and blood lead levels. Soil and dust samples from a lead mining community in Australia showed a high degree of bioavailability. Blood lead levels in 899 children (1 to 4 years of age) from a mining community showed that approximately 20% had blood lead levels greater than 25 µg/dl and over 85% had greater than 10 µg/dl. They concluded that ingestion of soil and dust was the main pathway and source for the elevated blood lead levels reported for children living in this community. In another lead mining and smelting area, an association between soil lead and blood lead levels in children age six-71 months was demonstrated (Cook, 1993). Additional evidence of a relationship between lead mining activities and blood lead was provided by Dutkiewicz et al. (1993) who determined that blood lead values in a mining area were significantly higher than a comparison population. Also, a study of a mining area in Missouri with lead mining and smelting activities demonstrated that blood lead levels were approximately twice as high in the mining area compared to a control area and that 14% of the children had blood lead levels greater than 10 µg/dl compared to none in the control group (Murgueytio et al., 1996).

The implications of elevated blood lead levels of children living in the study area goes beyond the children sampled for this study. The 1990 census recorded 1702 children between the ages of 0 and 72 months living in the Big River mine area. If 17% of these children were expected to have had elevated blood lead levels as determined in this study, 289 children in 1990 would have been expected to have blood lead levels greater than or equal to 10 µg/dl and, therefore, were at risk for toxicological effects such as decreased attention span, hyperactivity, lower IQ scores (Ernhardt et al., 1981; Needleman and Gatsonis, 1990), child developmental problems (Bellinger et al., 1987; Bellinger et al., 1991; Dietrich et al., 1987; Needleman et al., 1990; Ernhart et al., 1986; Lyngbye et al.,1990) and decreased general measures of cognition (Bergomi et al.,1989; Ferguson et al.,1988; Fulton et al.,1987; Hansen et al., 1989; Hawk et al.,1986; Hatzakis et al., 1989; Lansdown et al., 1986; Schroeder et al., 1985; Silva et al., 1988 Winneke et al., 1990; Yule et al., 1981). Estimating from 1990 census data, over 200 children are born each year into this area and become at risk for elevated blood leads resulting in approximately 34 new children becoming lead poisoned annually.

To further evaluate the contribution of mine waste to the excess elevated blood lead levels, a discussion of the relationship between lead in soil, dust, and paint should be considered. It was assumed that sources of soil and dust lead were similar in the study and control areas except for the presence of mining waste in the study area. This would be consistent with the environmental data and the results of the source characterization.

All environmental measures of soil and dust lead were many times higher in the study group compared to the control group. For example, the soil lead levels in the children's play areas were 10 times higher in the lead mining area averaging 1282 µg/g (ppm). A composite of six soil samples from the study area were analyzed for source characterization. Less than one percent derived from a paint source, between 50% and 60% derived from mining waste, and between 40% and 50% could not be determined as either waste or paint. Since the soil samples were from the yard distant from the drip line, they were not expected to have a large percentage of lead based paint. It was expected that the source for a large percentage of the yard samples would not be identifiable due to chemical transformations that would alter the samples 'original' physiochemical form. The percentage of soil that was identified as derived from mining waste probably resulted from the transport of mining waste as fill or from being recently wind blown into the area.

Source analysis of the household vacuum bag dust within the study area, based on particle volume, indicated the proportion derived from the mining waste was 26%, the proportion derived from a paint source was 16%, and the proportion from soil was 37%. In 15% of the lead identified, a specific originating source could not be determined. These results suggested that the waste piles were at least as important a contribution source as paint, but it is reasonable to assume that a large percent of the source derived from yard soil originated from the waste piles. The overall contribution, therefore, of the waste piles may be two to three times the contribution from paint, by both total particle volume and lead concentration.

Further evidence that soil and dust lead in the study area related to blood lead levels were the significant correlations in the study area but not in the control area. There was somewhat better correlation between dust lead and blood lead than soil lead and blood lead. This might be related to a child spending more time inside the home than playing in soil outside the home or it might be an artifact related to the greater variation in soil lead levels. The strongest correlation with blood lead levels in the study area was lead in dust on the floor, followed by indoor XRF values, followed by loading of lead on the window sill.

Total XRF values were significantly correlated with lead concentrations in vacuum bag, lead concentrations in soil at drip line, and dust wipe samples of window sills, but were not correlated with soil lead in play areas or with the lead concentration on the floor of the homes in the study area. This indicated that both indoor and outdoor lead based paint contributes to dust lead and to drip line soil lead but not to soil lead distant from the house.

This correlational analysis suggests that blood lead levels can be reduced by interventions that address all of these sources. Interventions might include remediation of mine waste material that children are exposed to through soil or dust and remediation or abatement of lead based paint in the homes. Educational interventions might include limiting exposure children have to soil by covering lead contaminated soil with non-contaminated soil and by planting yard vegetation. Children's exposure to dust can be reduced by better housecleaning techniques, by keeping children's hands and toys clean, and by controlling what a child puts in their mouths.

XRF values were slightly higher for indoor paint in the study area. To determine if this difference might confound the blood lead levels, an analysis of covariance adjusting for both indoor and outdoor XRF values was performed. The mean blood lead values were minimally affected by this adjustment. The adjusted mean values were still approximately twice as high in the study area. There was little or no difference in other potential confounders between the study and control groups and, therefore, no additional adjustments to the comparisons between study and control groups were necessary.

The results of this study were remarkably similar to those reported for Jasper County, Missouri, a mining area on the western side of the state (Murgueytio, 1996). In that area, both mining waste and past local smelting contributed to the lead levels. Fourteen percent of the children living in that mining area had blood lead levels greater than 10 µg/dl. In the study reported here, 17% had elevated blood lead levels. The average blood lead level in the Jasper County study was 6.25 µg/dl in the study group and 3.59 µg/dl in the control group. This is very similar to the average in the present study, 6.52 µg/dl and 3.44 µg/dl in the study and control groups, respectively.

It was originally suspected that blood lead levels might be higher in the Jasper County study compared to this study because of the presence of diverse smelting operations in Jasper County resulting in a lead form that might be more bioavailable. This proved not to be the case. Results of the Big River study were very similar to the Jasper County study resulting in the conclusion that mine waste, with or without smelting waste, is related to elevated blood lead levels. The results of the Jasper County and Big River studies combined strengthens the premise that exposure to lead mining waste elsewhere in the state or in the nation might result in elevated blood lead levels and, therefore, steps should be taken to reduce exposure to this lead source.

CONCLUSIONS

The results of this study indicated that blood lead levels were a product of exposure to lead mining waste, lead based paint, and other sources. Because the only substantial difference between the study and control area in terms of exposure to lead is the presence of lead mining, mining waste was the most reasonable explanation for the dramatic differences between the blood lead levels in the two communities.

RECOMMENDATIONS

1. Although mining waste accounts for the difference between the study and control area, both lead paint and soil/dust lead were related to blood lead levels. Blood lead levels can be reduced by efforts to both reduce exposure to mining waste and to reduce exposure to lead based paint.

2. An educational and environmental intervention program that addresses both of these sources should be initiated.

3. Future studies should focus on effective interventions to reduce exposure and on adverse neurobehavioral outcomes such as school achievement and IQ. XRF technology could be used to estimate long term exposure to lead by measuring accumulation of lead in bone. These measures of exposure could then be evaluated against markers of cognitive development.

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TABLES

Table 1.— Area Population by Age and Gender from 1990 U.S. Census Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997 Study Area

Bonne Terre

Age Group (years)	Male	Female	Total
<1	9	26	35
1-2	63	44	107
3-4	58	65	123
5-6	60	72	132
Subtotal	190	207	397
≥ 7	1,628	1,846	3,474
TOTAL	1,818	2,053	3,871

Desloge

Age Group (years)	Male	Female	Total
<1	22	22	44
1-2	61	52	113
3-4	59	61	120
5-6	58	62	120
Subtotal	200	197	297
≥ 7	1,743	2,010	2,753
TOTAL	1,943	2,207	4,150

Table 1.— (cont) Area Population by Age and Gender from 1990 U.S. Census Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

Park Hills

Age Group (years)	Male	Female	Total
<1	57	63	120
1-2	119	122	241
3-4	129	143	272
5-6	129	113	242
Subtotal	434	441	875
≥ 7	3,239	3,821	7,055
TOTAL	3,673	4,262	7,935

Leadwood

Age Group (years)	Male	Female	Total
<1	10	5	15
1-2	18	16	34
3-4	24	10	34
5-6	22	28	50
Subtotal	75	59	133
≥ 7	532	582	1,114
TOTAL	606	641	1,247

Table 1.— (cont) Area Population by Age and Gender from 1990 U.S. Census Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997 Control Area

Salem

Age Group (years)	Male	Female	Total
<1	26	67	93
1-2	91	37	128
3-4	47	50	97
5-6	78	35	113
Subtotal	242	189	431
>7	1753	2302	4055
TOTAL	1995	2491	4486

Table 2.— Quality Control Summary Results Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

Type	Analyte	Units	Number of Samples	Between PQL[1] - MDL[2]	Below MDL	Minimum	Maximum	Geometric Mean (GM)	Lnsd[3]	95% Confidence LCL[4]	UCL[5]
Field blanks Measured Value											
Cassette filters	lead	ug[6]	73	2	71	2.50	2.50	2.50	0.00		2.50
Dust wipes	lead	ug	118	35	83	2.50	13.75	4.95	1.06		40.08
Glove Wipes	lead	ug	3	2	1	2.50	25	11.60	1.33		797.48
Bag Wipes	lead	ug	4	0	4	2.50	2.50	2.50	0.00		2.50
Blind Reference (SRM) - Ratio of Primary Lab Value/Reference											
Soil	lead	ug/g	29	0	0	0.65	0.97	0.84	0.10	0.69	1.03
Cassette	lead	ug	60	0	0	0.01	0.93	0.49	0.78	0.10	2.30
	lead[7]	ug	58	0	0	0.15	0.93	0.55	0.38	0.26	1.17
Dust	lead	ug	8	0	0	0.76	0.93	0.85	0.06	0.73	1.00
Water	lead	ug/L	7	0	0	0.80	1.24	1.06	0.07	0.88	1.26
Split Samples - Ratio of Greater Value/Lessor Value											
Soil	lead	ug/g	62	0	0	1.00	11.38	1.43	0.50		3.90
	lead[7]	ug/g	59	0	0	1.00	3.01	1.30	0.27		2.22
Vacuum bags	lead	ug/g	14	0	0	1.02	3.75	1.52	0.46		4.06
Water	lead	ug/l	28	26	0	1.00	1.67	1.05	0.12		1.36
Side-By-Side - Ratio of Greater Value/Lessor Value											
Soil	lead	ug/g	35	1	0	1	63.91	1.64	0.77		7.87
	lead[7]	ug/g	34	1	0	1	6.76	1.47	0.44		3.62

1. PQL = Practical Quantification Limit, 2. MDL = Minimum Detection Limit, 3. Lnsd = Log Normal standard deviation, 4. LCL = Lower Confidence Limit, 5. UCL = Upper Confidence Limit, 6. ug = micrograms, 7. Results with removal of identified outliers.

Table 3.—Overview of Study and Control Area Canvass and Recruitment Effort Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

	Study Area		Control Area	
Area (square miles)		20		2
Population		17,270		4,484
Total number of homes		5,702		2,264
Total number of eligible homes for study		778		249
Recruitment Summary	**Percent**	**(n)**	**Percent**	**(n)**
Refused	39%	(307)	29%	(72)
Canceled	8%	(60)	14%	(34)
Moved	11%	(83)	10%	(25)
Ineligible	2%	(16)	10%	(25)
Unable to contact	10%	(78)	8%	(21)
Consented	30%	(235)	29%	(72)
Total	100%	(779)	100%	(249)

Table 4. —Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR[1]	STUDY (n = 235)	CONTROL (n = 72)	p-VALUE[2]
Person answering question			
Mother	85.1%	87.5%	
Father	8.9%	6.9%	
Grandparent	4.7%	4.2%	
Other person	1.3%	1.4%	.954
Age (years)	3.70 ± 1.77[3]	3.80 ± 1.72	.655
Gender			
Male	49.8%	47.2%	
Female	50.2%	52.8%	.403
Race			
Black	1.3%	0%	
White	98.7%	100%	NA[4]
Total gross household income before taxes:			
$\leq$ \$4,999	8.1%	20.8%	
\$5,000-\$9,999	8.1%	8.3%	
\$10,000-\$14,999	9.8%	11.1%	
\$15,000-\$19,999	9.8%	6.9%	
\$20,000-\$24,999	11.1%	4.2%	
\$25,000-\$29,999	11.1%	9.7%	
\$30,000-\$34,999	10.6%	8.3%	
\$35,000-\$39,999	8.1%	8.3%	
$\geq$ \$40,000	16.2%	20.8%	
Refused	0.9%	0%	
Don't Know	6.4%	1.4%	.149
Highest year of education completed by the mother of the child:			
No schooling	0%	0%	
Elementary School	12.8%	20.8%	
High School	49.8%	52.8%	
Technical or Trade School	9.8%	2.8%	
Junior/Community College	18.3%	15.3%	
Four year College/University	7.2%	6.9%	
Attended Graduate school	2.1%	1.4%	.277
Year house was built[5]			
<1900-1909	8.8%	0%	
1910-1919	3.6%	2.4%	
1920-1929	6.6%	2.4%	
1930-1939	8.8%	9.8%	
1940-1949	10.2%	12.2%	
1950-1959	10.2%	19.5%	
1960-1969	2.9%	24.4%	
1970-1979	16.8%	12.2%	
1980-1989	16.1%	4.9%	
1990-present	16.1%	12.2%	.001

Table 4. —(cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p- VALUE
House rented or owned?			
Rented	34.9%	54.2%	
Owned	62.6%	45.8%	
Other	2.6%	0%	.008
Type of water pipes			
Lead	1.7%	2.9%	
Plastic	45.7%	17.6%	
Galvanized Steel	10.4%	11.8%	
Copper	13.3%	50.0%	
Iron	0.6%	0%	
Mixed	27.7%	17.6%	
Other	0.6%	0%	<.001
Source of house water for drinking			
Public water	91.9%	98.6%	
Well	2.6%	1.4%	
Other	5.5%	0%	NA
Source of house water for cooking			
Public water	96.2%	98.6%	
Well	2.1%	1.4%	
Other	1.7%	0%	NA
Source of child's water for drinking			
Public water	78.6%	97.2%	
Well	3.8%	1.4%	
Bottled	17.5%	1.4%	NA
Source of child's water for cooking			
Public water	91.9%	98.6%	
Well	2.1%	1.4%	
Bottled	6.0%	0%	NA
Water in kitchen faucet filtered or treated			
Yes	16.2%	14.5%	
No	83.8%	85.5%	.450
Any part of house repainted, sanded, or stripped chemically or by heat within last year?			
Yes	48.7%	47.8%	
No	51.3%	52.2%	.504

Table 4. —(cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p-VALUE
What part of house was work done in?			
Bedroom	45.3%	44.0%	
Living Room	22.1%	20.0%	
Bathroom	7.4%	16.0%	
Kitchen	8.4%	8.0%	
Outside walls	11.6%	12.0%	
Porch	5.3%	0%	
Deck	0%	0%	.703
How often air conditioning is used during summer			
Never	7.2%	11.3%	
Rarely	1.3%	2.8%	
Sometimes	13.2%	5.6%	
Frequently	32.8%	19.7%	
Always	45.5%	60.6%	.037
Where air conditioning is used			
Central	48.9%	50.0%	
Living/family room	33.8%	37.5%	
Child's bedroom	3.7%	1.6%	
Other bedroom	5.5%	0%	
Kitchen	1.8%	9.4%	
Other	6.4%	1.6%	.012
Mine, smelter, or lead industry materials used in or around house or yard			
Yes	20.4%	3.8%	
No	79.6%	96.2%	.002
Pets go in and out of house			
Yes	38.2%	38.0%	
No	61.8%	62.0%	.548
In the last 90 days, any member of household:			
Painted pictures with artists paints?			
Yes	6.9%	9.7%	
No	93.1%	90.3%	.283
Painted, stained, or refinished furniture?			
Yes	17.5%	19.4%	
No	82.5%	80.6%	.415
Painted the inside or outside of a home or building?			
Yes	37.3%	29.6%	
No	62.7%	70.4%	.146
Worked with stained glass?			
Yes	0.4%	0%	
No	99.6%	100%	NA
Cast lead into fishing sinkers, bullets or anything else?			
Yes	4.7%	5.6%	
No	95.3%	95.4%	.474

Table 4. —(cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p- VALUE
In the last 90 days, any member of household:			
Worked with soldering sheets of metal?			
Yes	7.9%	2.9%	
No	92.1%	97.1%	.110
Worked with soldering pipes?			
Yes	9.5%	4.2%	
No	90.5%	95.8%	.113
Repaired auto radiators?			
Yes	9.0%	1.4%	
No	91.0%	98.6%	.022
Worked on auto bodies or auto maintenance? (includes mechanics)			
Yes	38.9%	21.4%	
No	61.1%	78.6%	.005
Worked at a sewage treatment plant?			
Yes	0.4%	0%	
No	99.6%	100%	NA
Made pottery?			
Yes	0.9%	0%	
No	99.1%	100%	NA
Ridden a dirt bike, mountain bike, or ATV in the local area?			
Yes	15.7%	19.4%	
No	84.3%	80.6%	.284
Welded?			
Yes	13.7%	8.6%	
No	86.3%	91.4%	.178
Cleaned or repaired firearms?			
Yes	19.8%	12.7%	
No	80.2%	87.3%	.115
Visited indoor firearm target ranges?			
Yes	1.7%	1.4%	
No	98.3%	98.6%	NA
Done wire/cable cutting or splicing?			
Yes	23.2%	15.7%	
No	76.8%	84.3%	.120
Casted or smelted lead?			
Yes	2.6%	1.4%	
No	97.4%	98.6%	NA
Worked in plastics manufacture?			
Yes	2.6%	0%	
No	97.4%	100%	NA
Worked in battery manufacture?			
Yes	0%	1.4%	
No	100%	98.6%	NA
Worked in pipe machining?			
Yes	1.7%	0%	
No	98.3%	100%	NA

Table 4. —(cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p- VALUE
In the last 90 days, any member of household:			
Done electroplating with lead solutions?			
Yes	0%	0%	
No	100%	100%	NA
Worked in refining gasoline?			
Yes	0%	0%	
No	100%	100%	NA
Worked in paint, glaze, and ink manufacture?			
Yes	1.7%	0%	
No	98.3%	100%	NA
Worked in rubber manufacture?			
Yes	1.3%	0%	
No	98.7%	100%	NA
Worked in scrap metal recovery?			
Yes	7.7%	5.6%	
No	92.3%	94.4%	NA
Had any other lead-related job of activity?			
Yes	1.3%	8.3%	
No	98.7%	91.7%	NA
People living in house worked in mining or a mining- related job in last 90 days?			
Yes	3.0%	6.9%	
No	97.0%	93.1%	.123
For those answering yes, how often does the person wear their clothes home after working?			
Never	71.4%	40.0%	
Rarely	0%	0%	
Sometimes	0%	0%	
Frequently	0%	0%	
Always	28.6%	60.0%	NA
For those answering yes, how often does the person come home from work without showering?			
Never	57.1%	40.0%	
Rarey	0%	0%	
Sometimes	0%	20.0%	
Frequently	0%	0%	
Always	42.9%	40.0%	NA
When food or drinks are prepared, served, stored, how often are they placed in clay pottery or ceramic dishes which were homemade or made in another country?			
Never	95.7%	86.1%	
Rarely	3.0%	11.1%	
Sometimes	0.4%	2.8%	
Frequently	0.9%	0%	
Always	0%	0%	NA

Table 4. —(cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p- VALUE
When food or drinks are prepared, served, stored, how often are they placed in copper or pewter dishes or containers?			
Never	97.4%	98.6%	
Rarely	2.1%	1.4%	
Sometimes	0.4%	0%	
Frequently	0%	0%	
Always	0%	0%	NA
When food or drinks are stored or put away, how often are they stored in the original can after being opened?			
Never	87.2%	83.3%	
Rarely	7.7%	11.1%	
Sometimes	3.8%	2.8%	
Frequently	1.3%	2.8%	
Always	0%	0%	.614
How often do you vacuum?			
Never	3.4%	1.4%	
Rarely	2.1%	1.4%	
Sometimes	13.2%	13.9%	
Frequently	56.0%	69.4%	
Always	25.2%	13.9%	.218
How often do you dry sweep?			
Never	7.7%	11.1%	
Rarely	5.1%	6.9%	
Sometimes	10.7%	11.1%	
Frequently	37.6%	45.8%	
Always	38.9%	25.0%	.285
How often do you mop?			
Never	17.0%	22.2%	
Rarely	4.7%	9.7%	
Sometimes	28.9%	36.1%	
Frequently	37.9%	26.4%	
Always	11.5%	5.6%	.087
How often do you wet wipe?			
Never	3.8%	1.4%	
Rarely	5.5%	5.6%	
Sometimes	22.6%	23.6%	
Frequently	47.7%	61.1%	
Always	20.4%	8.3%	.108

Table 4. —(cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p- VALUE
How often do you dry dust?			
Never	17.1%	20.8%	
Rarely	17.5%	20.8%	
Sometimes	28.6%	41.7%	
Frequently	29.9%	12.5%	
Always	6.8%	4.2%	.029
How often do you use other house cleaning methods?			
Never	65.2%	47.9%	
Rarely	7.3%	14.1%	
Sometimes	14.2%	15.5%	
Frequently	10.3%	22.5%	
Always	3.0%	0%	.008
How many times per month are the following rooms cleaned:			
Kitchen	22.4 ± 16.5	28.1 ± 16.7	.011
Child's bedroom	12.4 ±11.5	12.0 ±11.0	.783
Living/family room	19.0 ± 12.9	20.7 ± 16.0	.354
How long do you spend cleaning the following rooms each time you clean them? (minutes)			
Kitchen	36.6 ±35.4	39.9 ± 18.0	.294
Child's bedroom	34.4 ± 33.5	32.5 ± 20.9	.568
Living/family room	29.2 ±23.5	28.7 ± 13.7	.824
Do you have a vacuum cleaner?			
Yes	94.5%	94.4%	
No	5.5%	5.6%	.595
If yes, how long ago was the vacuum cleaner last used? (days)	2.3 ± 3.2	2.7 ± 4.9	.372
If yes, how long ago was the vacuum cleaner bag emptied or last changed? (days)	23.6 ± 38.2	24.4 ± 39.6	.887
Does anyone smoke tobacco products in your home?			
Yes	58.7%	50.0%	
No	41.3%	50.0%	.121
If yes, how many people smoke in this house?	1.4 ± 2.0	2.1 ±4.2	.193
How long has the child been living in this home? (months)	28.4 ± 21.7	19.8 ± 17.4	.001
Does child breast feed? (Only for participants $\leq$2yrs old)			
Yes	38.8%	64.3%	
No	61.2%	35.7%	.073
Does child currently take a bottle?	45.8%	40.9%	
Yes			
No	54.2%	59.1%	.438

Table 4. —(cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p- VALUE
Hours per day the child usually spends playing on the floor in this house:	5.5 $\pm$ 3.0	5.4 $\pm$ 3.4	.837
How often does the child play outdoors?			
Never	1.3%	5.6%	
Rarely	9.4%	12.5%	
Sometimes	26.8%	19.4%	
Frequently	49.8%	41.7%	
Always	12.8%	20.8%	.053
If the child plays outdoors, hours per day, on the average, the child plays outdoors:	2.6 $\pm$1.9	3.2 $\pm$2.8	.073
Where does child usually play when outside this house?			
Back yard	51.1%	36.6%	
Front yard	25.8%	35.2%	
Side yard	12.4%	12.7%	
Street and side walk	1.7%	2.8%	
Other	9.0%	12.7%	.267
When the child is not playing around the house, where does he/she usually play?			
Neighbor's yard	24.2%	27.8%	
Playground	5.2%	5.6%	
Near or around creek or ditch	0%	2.8%	
On or near sidewalks or streets	1.7%	0%	
Park	5.2%	6.9%	
Only plays around the home	30.7%	6.9%	
Other	32.9%	50.0%	.798
How often does the child play on a grassy area?			
Never	5.2%	6.9%	
Rarely	10.3%	5.6%	
Sometimes	19.3%	18.1%	
Frequently	45.5%	48.6%	
Always	19.7%	20.8%	.761
How often does the child play on concrete/asphalt?			
Never	12.9%	8.5%	
Rarely	30.2%	25.4%	
Sometimes	29.3%	35.2%	
Frequently	24.6%	26.8%	
Always	3.0%	4.2%	.678
How often does the child play in dirt?			
Never	9.9%	11.1%	
Rarely	25.3%	19.4%	
Sometimes	28.3%	29.2%	
Frequently	27.5%	27.8%	
Always	8.6%	12.5%	.837

Table 4. — (cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p- VALUE
Is there any park or common play areas where the child plays?			
Yes	50.6%	56.9%	
No	49.4%	43.1%	.212
Does child :			
Crawl	5.5%	4.3%	
Walk	76.6%	52.2%	
Both	17.9%	43.5%	NA
How often does child take food, snacks, or candy outside to eat?			
Never	22.7%	23.6%	
Rarely	38.2%	31.9%	
Sometimes	24.9%	26.4%	
Frequently	9.4%	12.5%	
Always	4.7%	5.6%	.872
How often does the child take a bottle or pacifier outside with them?			
Never	85.5%	88.7%	
Rarely	4.7%	5.6%	
Sometimes	5.1%	1.4%	
Frequently	1.7%	4.2%	
Always	3.0%	0%	NA
How often does the child wash hands or face before eating?			
Never	0.4%	2.8%	
Rarely	4.3%	5.6%	
Sometimes	15.0%	28.2%	
Frequently	28.2%	26.8%	
Always	52.1%	36.6%	.022
How often does the child wash hands or face before going to sleep?			
Never	2.1%	0%	
Rarely	4.3%	0%	
Sometimes	12.3%	15.3%	
Frequently	23.8%	25.0%	
Always	57.4%	59.7%	.283
How often does the child wash hands or face after playing with dirt or sand?			
Never	3.5%	2.8%	
Rarely	2.6%	0%	
Sometimes	9.7%	15.3%	
Frequently	20.7%	20.8%	
Always	63.4%	61.1%	.465

Table 4. — (cont) Questionnaire Responses by Factors and GroupBig River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n=72)	p- VALUE
Number of times the child is bathed or given a shower per week:	6.4 ± 2.1	6.2 ± 2.0	.546
How often has the child used a pacifier in the last 6 months?			
Never	88.5%	88.7%	
Rarely	3.0%	1.4%	
Sometimes	1.7%	1.4%	
Frequently	2.1%	2.8%	
Always	4.7%	5.6%	NA
How often does the child suck their thumb or fingers?			
Never	71.1%	65.3%	
Rarely	8.9%	6.9%	
Sometimes	10.6%	13.9%	
Frequently	4.7%	11.1%	
Always	4.7%	2.8%	.269
How often does the child chew on their fingernails?			
Never	58.3%	65.3%	
Rarely	16.2%	13.9%	
Sometimes	12.3%	11.1%	
Frequently	8.9%	2.8%	
Always	4.3%	6.9%	.366
Does the child have a favorite blanket or toy?			
Yes	44.3%	51.4%	
No	55.7%	48.6%	.177
For those answering yes, how often does the child carry this around during the day?			
Never	21.9%	13.2%	
Rarely	19.0%	15.8%	
Sometimes	21.9%	28.9%	
Frequently	25.7%	34.2%	
Always	11.4%	7.9%	.577
For those answering yes, how often does the child put this blanket or toy in their mouth?			
Never	51.9%	31.6%	
Rarely	16.3%	26.3%	
Sometimes	15.4%	7.9%	
Frequently	7.7%	23.7%	
Always	8.7%	10.5%	.025
How often does the child put things other than food into their mouth?			
Never	15.9%	17.4%	
Rarely	27.9%	26.1%	
Sometimes	27.0%	26.1%	
Frequently	15.9%	20.3%	
Always	13.3%	10.1%	.879

Table 4. — (cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p- VALUE
How often does the child put their mouth on furniture or on the window sill?			
Never	44.4%	37.5%	
Rarely	20.9%	25.0%	
Sometimes	21.4%	23.6%	
Frequently	9.4%	11.1%	
Always	3.8%	2.8%	.827
How often does the child swallow things other than food?			
Never	74.9%	66.7%	
Rarely	17.0%	25.0%	
Sometimes	6.0%	6.9%	
Frequently	1.7%	1.4%	
Always	0.4%	0%	.593
How often does the child put paint chips in their mouth?			
Never	96.6%	97.1%	
Rarely	1.7%	2.9%	
Sometimes	1.7%	0%	
Frequently	0%	0%	
Always	0%	0%	NA
Does your household have a vegetable garden?			
Yes	29.5%	16.7%	
No	70.5%	83.3%	.020
For those answering yes, how often does the child eat vegetables grown in your garden?			
Never	21.9%	42.9%	
Rarely	20.5%	7.1%	
Sometimes	27.4%	14.3%	
Frequently	24.7%	14.3%	
Always	5.5%	21.4%	.083
How often does the child eat vegetables grown elsewhere in the local area?			
Never	44.6%	22.2%	
Rarely	18.2%	27.8%	
Sometimes	23.8%	30.6%	
Frequently	10.8%	13.9%	
Always	2.6%	5.6%	.015
Has the child ever been treated with traditional, folk, or herbal medications?			
Yes	6.4%	7.0%	
No	93.6%	93.0%	.520
Number of people living in house:	4.4 ± 1.4	4.0 ± 1.2	.024

Table 4. — (cont) Questionnaire Responses by Factors and Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY (n = 235)	CONTROL (n = 72)	p- VALUE
Amount of money spent on food per week in household:			
≤ $25	1.7%	2.8%	
$25-$50	16.7%	26.4%	
$50-$75	38.0%	36.1%	
$75-$100	30.3%	23.6%	
> $100	13.2%	11.1%	.382

1. Some factors had more responses offered than are displayed in this table. If no participants answered a particular response, the response was not included in the table.
2. P-values are for proportions from chi-square analysis and for interval data from t-test.
3. Mean plus or minus standard deviation.
4. NA- not calculated because more than 25% of cells had less than five subjects expected per cell.
5. Results do not include responses of "don't know" or "refused". There were 98 such responses in the study group and 31 such responses in the control group.

Table 5. —Mean Blood Lead and Environmental Lead Results Compared between Study and Control Groups Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR[1]	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)	p- VALUE
Blood lead (all values included) (µg/dl)	6.52 ± 3.92 (226)	3.43 ± 1.98 (69)	.000
Lead concentration in tap water (µg/l)	2.38 ± 7.23 (235)	3.55± 3.02 (72)	.181
Lead concentration in drip line soil(µg/g)	1794.62 ± 2030.58 (231)	625.62 ± 2224.31(71)	.000
Lead concentration in play area soil (µg/g)	1282.28 ± 1447.11 (222)	127.15± 211.89 (60)	.000
Lead concentration in yard soil (µg/g)	1078.76 ± 120.88 (233)	87.57 ± 180.16 (72)	.000
Lead concentration in vacuum bag (µg/g)	1214.49 ± 440.76 (201)	173.02 ± 238.90 (61)	.001
Lead loading of floor cassette vacuum (µg/ft²)	18.04 ± 56.01 (226)	4.10± 18.59 (65)	.002
Lead concentration of floor cassette vacuum (µg/g)	763.23 ± 2122.28 (234)	283.69 ± 690.95 (67)	.070
Visible dust during floor cassette vacuum (lower the value the less visible the dust)	.82 ± .21 (227)	.84 ± .21 (72)	.560
Lead loading in window sill dust wipe (µg/ft²)	1641.52 ± 5534.92 (221)	196.95 ± 319.34 (66)	.000
Visible loose dust during window sill dust wipe (lower the value the less the loose dust)	.93 ± .15 (221)	.91± .17 (66)	.480
Visible dust when blown during window sill dust wipe (lower the value the less visible the dust)	.92 ±.15 (221)	.90 ± .18 (66)	.344
Observed visible soiling of dust wipe sampling material (lower the value the less visible the soiling)	.89 ± .21 (219)	.93 ± .14 (66)	.085
XRF for all indoor surfaces (mg/cm²)	.28 ±.51 (235)	.14 ± .22 (72)	.001
XRF for indoor surfaces by room (mg/cm²)	.28 ± .51 (235)	.14 ± .22 (72)	.001
XRF for indoor surfaces by room and friction (mg/cm²)	.34 ± .58 (235)	.22 ± .36 (72)	.031
XRF for indoor friction surfaces only (mg/cm²)	.36 ±.61 (235)	.22 ± .36 (72)	.013
XRF >0 for indoor surfaces (mg/cm²)	1.32 ± 1.21 (192)	1.17 ± 1.22 (51)	.405
XRF ≥ 0.7 for indoor surfaces (mg/cm²)	3.14 ± 1.32 (130)	2.75 ± 1.38 (33)	.141
XRF for indoor surfaces weighted[2] by d/t (mg/cm²)	3.18 ± 1.40 (101)	2.93 ± 1.57 (18)	.488
XRF for indoor surfaces weighted by d/t by room (mg/cm²)	2.20 ± 1.28 (101)	1.52 ± 1.04 (18)	.036
XRF for indoor surfaces weighted by d/t by room and friction (mg/cm²)	1.05 ± .83 (101)	.57 ± .43 (18)	.001
XRF for indoor friction surfaces only weighted by d/t (mg/cm²)	1.66 ± 1.15 (101)	1.01 ± .72 (18)	.003
XRF for all outdoor surfaces (mg/cm²)	.29 ±.36 (235)	.34 ± .41 (72)	.346
XRF >0 for outdoor surfaces (mg/cm²)	1.93 ± 1.55 (188)	2.26 ± 1.93 (57)	.244
XRF ≥ 0.7 for outdoor surfaces (mg/cm²)	3.46 ± 1.62 (150)	3.98 ± 2.50 (44)	.189
Observed general condition of rooms (scale of 1=poor to 5=good)	3.22 ± .89 (235)	3.52 ± .99 (72)	.014

1. Bolded factors showed a significant difference ($p < .05$) between the study and control groups.

2. d/t = damaged area/total wall area. Contains only XRF values ≥ 0.7 mg/cm².

Table 6. —Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
Gender		
Male	6.76 ± 4.63 (112)	3.44 ± 1.98 (32)
Female	6.28 ± 3.07 (114)	3.43 ± 2.01 (37)
p-value[1]	.360	.992
Race		
Black	6.33 ± 4.16 (3)	-
White	6.52 ± 3.93 (223)	3.43 ± 1.98 (69)
p-value	.935	-
Total gross household income before taxes:		
≤ $4,999	8.11 ± 4.33 (19)	4.00 ± 2.45 (15)
$5,000-$9,999	9.26 ± 6.40 (19)	4.83 ± 2.79 (6)
$10,000-$14,999	7.09 ± 3.83 (22)	4.00 ± 1.93 (8)
$15,000-$19,999	6.00 ± 2.02 (22)	2.00 ± - (3)
$20,000-$24,999	7.08 ± 5.11 (26)	4.33 ± 1.15 (3)
$25,000-$29,999	6.52 ± 3.29 (25)	2.86 ± 1.57 (7)
$30,000-$34,999	6.09 ± 3.25 (22)	2.83 ± 1.17 (6)
$35,000-$39,999	4.78 ± 1.70 (18)	3.00 ± 1.55 (6)
≥ $40,000	5.18 ± 2.68 (38)	2.93 ± 1.73 (14)
p-value	.010	.280
Highest year of education completed by the mother of the child:		
Elementary School	7.41 ± 2.88 (29)	4.13 ± 2.33 (15)
High School	6.76 ± 4.65 (112)	3.53 ± 1.99 (36)
Technical or Trade School	7.17 ± 3.01 (23)	5.00 ± 1.41 (2)
Junior/Community College	6.10 ± 3.10 (41)	2.31 ± 1.25 (10)
Four year College/University	4.06 ± 2.05 (16)	2.60 ± 1.14 (5)
Attended Graduate school	4.20 ± 1.30 (5)	2.00 ± - (1)
p-value	.048	.159
Year house was built[2]		
<1900-1909	6.50 ± 3.03 (10)	-
1910-1919	11.6 ± 12.9 (5)	3.00 ± - (1)
1920-1929	6.67 ±3 .61 (9)	5.00 ± - (1)
1930-1939	6.18 ± 3.19 (11)	3.00 ± 1.83 (4)
1940-1949	6.29 ± 2.95 (14)	4.20 ± 1.30 (5)
1950-1959	6.29 ± 3.34 (14)	2.88 ± 1.13 (8)
1960-1969	4.75 ± 2.22 (4)	2.80 ± 1.81 (10)
1970-1979	5.41 ± 2.52 (22)	2.20 ± 1.10 (5)
1980-1989	6.24 ± 3.00 (21)	1.00 ± - (2)
1990-present	4.32 ± 2.34 (22)	2.67 ± .58 (3)
p-value	.045	.232

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
House built prior to 1960	6.78 ± 4.65 (63)	3.37 ± 1.38 (19)
House built after 1959	5.28 ± 2.67 (69)	2.45 ± 1.47 (20)
p-value	.023	.052
House rented of owned?		
Rented	7.07 ± 3.35 (81)	4.05 ± 2.28 (38)
Owned	6.20 ± 4.14 (139)	2.68 ± 1.19 (31)
p-value	.180	.002
Type of water pipes		
Lead	5.67 ± 1.53 (3)	3.00 ± - (1)
Plastic	6.21 ± 2.96 (76)	4.60 ± 1.14 (5)
Galvanized Steel	10.18 ± 8.38 (17)	3.67 ± 3.06 (3)
Copper	5.35 ± 2.81 (23)	3.19 ± 1.80 (16)
Iron	4.00 ± - (1)	-
Mixed	6.84 ± 3.70 (45)	3.50 ± 1.52 (6)
Other	7.00 ± - (1)	-
p-value	.011	.655
Source of house water for drinking		
Public water	6.71 ± 3.95 (208)	3.47 ± 1.97 (68)
Well	2.33 ± 1.03 (6)	1.00 ± - (1)
p-value	.007	-
Source of house water for cooking		
Public water	6.68 ± 3.91 (217)	3.47 ± 1.97 (68)
Well	2.60 ± .89 (5)	1.00 ± - (1)
p-value	.021	-
Source of child's water for drinking		
Public water	6.79 ± 4.09 (176)	3.45 ± 1.98 (67)
Well	3.11 ± 2.09 (9)	1.00 ± - (1)
Bottled	.6.15 ± 3.05 (40)	5.00 ± - (1)
p-value	.018	
Source of child's water for cooking		
Public water	6.68 ± 3.96 (207)	3.47 ± 1.97 (68)
Well	2.60 ± .89 (5)	1.00 ± - (1)
Bottled	5.62 ± 3.23 (13)	
p-value	.049	
Any part of house repainted, sanded, or stripped chemically or by heat within last year?		
Yes	6.71 ± 3.87 (108)	3.12 ± 1.52 (33)
No	6.34 ± 3.99 (115)	3.30 ± 1.88 (33)
p-value	.479	.667

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
Mine, smelter, or lead industry materials used in or around house or yard		
Yes	6.35 ± 4.48 (40)	3.50 ± 2.12 (2)
No	6.54 ± 3.96 (157)	3.31 ± 1.91 (48)
p-value	.798	.893
Pets go in and out of house		
Yes	6.97 ± 4.79 (87)	3.85 ± 2.25 (27)
No	6.26 ± 3.26 (137)	3.20 ± 1.78 (41)
p-value	.193	.185
In the last 90 days, any member of household:		
Worked on auto bodies or auto maintenance? (includes mechanics)		
Yes	7.37 ± 3.78 (87)	3.80 ± 2.40 (15)
No	6.01 ± 3.93 (138)	3.29 ± 1.88 (52)
p-value	.001	.387
Made pottery?		
Yes	9.00 ± 1.41 (2)	-
No	6.50 ± 3.93 (224)	3.43 ± 1.98 (69)
p-value	.370	-
Ridden a dirt bike, mountain bike, or ATV in the local area?		
Yes	6.47 ± 3.16 (34)	3.43 ± 2.31 (14)
No	6.53 ± 4.05 (192)	3.44 ± ± 1.91 (55)
p-value	.940	.990
Welding?		
Yes	6.94 ± 3.54 (31)	3.67 ± 1.63 (6)
No	6.47 ± 3.98 (194)	3.36 ± 2.00 (61)
p-value	.548	.718
Cleaned or repaired firearms?		
Yes	7.56 ± 5.45 (45)	4.00 ± 2.74 (9)
No	6.25 ± 3.41 (178)	3.36 ± 1.87 (59)
p-value	.131	.3710
Casting or smelting lead?		
Yes	10.67 ± 3.72 (6)	2.00 ± - (1)
No	6.38 ± 3.87 (219)	3.36 ± 1.83 (67)
p-value	.008	-
Other lead-related job of activity?		
Yes	8.33 ± 7.51 (3)	4.83 ± 2.99 (6)
No	6.46 ± 3.90 (218)	3.30 ± 1.84 (63)
p-value	.708	.070

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
People living in house worked in mining or a mining-related job in last 90 days?		
Yes	9.71 ± 4.99 (7)	5.20 ± 3.11 (5)
No	6.42 ± 3.85 (219)	3.30 ± 1.83 (64)
p-value	.028	.038
When food or drinks are prepared, served, stored, how often are they placed in clay pottery or ceramic dishes which were homemade or made in another country?		
Never	6.61 ± 3.98 (215)	3.42 ± 2.07 (60)
Rarely	4.57 ± 1.90 (7)	3.57 ± 1.51 (7)
Sometimes	-	3.50 ± .71 (2)
Frequently	4.50 ± .71 (2)	-
p-value	.307	.981
When food or drinks are prepared, served, stored, how often are they placed in copper or pewter dishes or containers?		
Never	6.51 ± 3.93 (221)	3.34 ± 1.93 (67)
Rarely	6.00 ± 3.56 (4)	6.00 ± - (1)
Sometimes	11.00 ± - (1)	-
p-value	.504	.178
When food or drinks are stored or put away, how often are they stored in the original can after being opened?		
Never	6.66 ± 4.07 (197)	3.48 ± 2.05 (58)
Rarely	5.28 ± 2.47 (18)	3.57 ± .98 (7)
Sometimes	5.50 ± 2.98 (8)	3.50 ± 3.54 (2)
Frequently	7.33 ± 2.08 (3)	1.50 ± .71 (2)
p-value	.438	.587
How often do you vacuum?		
Never	8.25 ± 4.13 (8)	10.00 ± - (1)
Rarely	5.80 ± 1.30 (5)	2.00 ± - (1)
Sometimes	6.90 ± 4.75 (30)	2.40 ± 1.08 (10)
Frequently	6.02 ± 3.95 (127)	3.57 ± 2.01 (47)
Always	7.25 ± 3.35 (56)	3.30 ± 1.25 (10)
p-value	.200	.004
How often do you dry sweep?		
Never	6.28 ± 2.93 (18)	3.71 ± 2.93 (7)
Rarely	5.82 ± 2.52 (11)	3.80 ± .84 (5)
Sometimes	5.44 ± 2.79 (25)	3.38 ± 2.26 (8)
Frequently	5.71 ± 3.01 (86)	3.59 ± 2.06 (32)
Always	7.78 ± 4.93 (86)	2.94 ± 1.56 (17)
p-value	.004	.822

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
How often do you mop?		
Never	6.00 ± 2.86 (39)	3.40 ± 1.99 (15)
Rarely	5.70 ± 1.77 (10)	3.14 ± 1.46 (7)
Sometimes	6.38 ± 3.81 (65)	3.08 ± 1.69 (24)
Frequently	6.68 ± 4.62 (85)	4.00 ± 2.43 (19)
Always	7.37 ± 3.71 (27)	3.50 ± 2.38 (4)
p-value	.627	.663
How often do you wet wipe?		
Never	6.12 ± 2.64 (8)	-
Rarely	6.23 ± 3.00 (13)	2.75 ± .50 (4)
Sometimes	6.68 ± 3.28 (53)	4.76 ± 2.59 (17)
Frequently	6.04 ± 4.17 (106)	2.98 ± 1.55 (42)
Always	7.59 ± 4.30 (46)	3.33 ± 1.97 (6)
p-value	.263	.012
How often do you dry dust?		
Never	6.56 ± 3.09 (39)	3.57 ± 1.55 (14)
Rarely	6.44 ± 5.13 (41)	3.87 ± 2.56 (15)
Sometimes	6.97 ± 4.56 (63)	3.47 ± 1.96 (30)
Frequently	6.23 ± 3.00 (66)	3.00 ± 1.53 (7)
Always	6.31 ± 2.91 (16)	1.33 ± .58 (3)
p-value	.871	.349
How often do you use other house cleaning methods?		
Never	6.73 ± 4.31 (144)	3.58 ± 2.03 (31)
Rarely	7.06 ± 3.54 (17)	3.50 ± 1.72 (10)
Sometimes	6.15 ± 3.25 (33)	3.45 ± 2.62 (11)
Frequently	5.67 ± 2.76 (24)	3.25 ± 1.65 (16)
Always	6.50 ± 2.59 (6)	-
p-value	.713	.962
Does anyone smoke tobacco products in your home?		
Yes	7.07 ± 4.14 (133)	3.82 ± 2.39 (34)
No	5.73 ± 3.46 (93)	3.06 ± 35 (35)
p-value	.011	.112
Does child breast feed? (Only for participants ≤2yrs old)		
Yes	5.33 ± 1.15 (3)	-
No	6.69 ± 3.39 (65)	3.50 ± 2.22 (16)
p-value	.494	-

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
Does child currently take a bottle?		
Yes	6.66 ± 3.91 (29)	3.62 ± 2.92 (8)
No	6.46 ± 2.91 (39)	3.58 ± 1.88 (12)
p-value	.816	.969
How often does the child play outdoors?		
Never	2.00 ± - (1)	2.00 ± - (3)
Rarely	6.71 ± 4.23 (21)	4.00 ± 2.93 (8)
Sometimes	6.35 ± 4.04 (62)	3.23 ± 2.65 (13)
Frequently	6.13 ± 2.93 (112)	3.23 ± 1.43 (30)
Always	8.33 ± 5.92 (30)	4.00 ± 1.85 (15)
p-value	.058	.429
Where does child usually play when outside this house?		
Back yard	6.09 ± 3.15 (115)	2.96 ± 1.57 (25)
Front yard	6.93 ± 3.44 (60)	4.00 ± 1.91 (24)
Side yard	7.11 ± 6.02 (27)	4.44 ± 2.79 (9)
Street and side walk	3.75 ± 1.26 (4)	3.00 ± 1.41 (2)
Other	7.79 ± 5.57 (19)	2.38 ± 1.92 (8)
p-value	.153	.085
When the child is not playing around the house, where does he/she usually play?		
Neighbor's yard	7.00 ± 4.61 (55)	2.95 ± 1.32 (20)
Playground	7.92 ± 3.68 (12)	4.33 ± 1.15 (3)
On or near sidewalks or streets	6.00 ± 2.16 (4)	5.00 ± 4.24 (2)
Park	6.45 ± 7.17 (11)	5.20 ± 3.49 (5)
Only plays around the home	6.39 ± 3.69 (70)	3.40 ± 2.41 (5)
Other	6.18 ± 2.98 (71)	3.29 ± 1.85 (34)
p-value	.705	.205
How often does the child play on a grassy area?		
Never	6.36 ± 3.88 (11)	1.75 ± .50 (4)
Rarely	5.96 ± 2.84 (24)	1.67 ± .58 (3)
Sometimes	5.93 ± 3.65 (45)	3.54 ± 2.37 (13)
Frequently	6.64 ± 3.61 (102)	3.23 ± 1.57 (35)
Always	7.30 ± 5.24 (43)	4.71 ± 2.30 (14)
p-value	.509	.017
How often does the child play on concrete/asphalt?		
Never	7.11 ± 4.00 (28)	2.40 ± 1.14 (5)
Rarely	6.74 ± 3.56 (69)	4.50 ± 2.85 (18)
Sometimes	5.65 ± 3.17 (66)	3.12 ± 1.13 (25)
Frequently	6.17 ± 3.04 (54)	3.18 ± 1.74 (17)
Always	12.14 ± 10.14 (7)	3.67 ± 2.08 (3)
p-value	.001	.105

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
How often does the child play in dirt?		
Never	5.52 ± 3.03 (21)	3.29 ± 3.25 (7)
Rarely	5.88 ± 3.69 (57)	2.64 ± 2.27 (14)
Sometimes	6.23 ± 3.38 (64)	3.20 ± 1.20 (20)
Frequently	6.73 ± 3.15 (62)	4.05 ± 1.85 (20)
Always	9.70 ± 6.89 (20)	4.00 ± 1.85 (8)
p-value	.003	.277
Is there any park or common play areas where the child plays?		
Yes	6.48 ± 3.81 (114)	3.74 ± 2.02 (39)
No	6.53 ± 4.05 (109)	3.03 ± 1.88 (30)
p-value	.925	.141
How often does child take food, snacks, or candy outside to eat?		
Never	6.50 ± 3.20 (48)	3.29 ± 2.46 (14)
Rarely	5.97 ± 3.62 (87)	3.48 ± 1.93 (23)
Sometimes	6.44 ± 3.08 (57)	3.37 ± 1.89 (19)
Frequently	7.64 ± 3.44 (22)	3.00 ± 1.66 (9)
Always	9.55 ± 9.46 (11)	5.00 ± 1.63 (4)
p-value	.037	.562
How often does the child take a bottle or pacifier outside with them?		
Never	6.51 ± 3.68 (196)	3.17 ± 1.61 (60)
Rarely	5.10 ± 2.08 (10)	7.50 ± 3.00 (4)
Sometimes	7.36 ± 4.82 (11)	2.00 ± - (1)
Frequently	13.33 ± 13.05 (3)	2.67 ± .58 (3)
Always	4.33 ± 1.03 (6)	-
p-value	.012	<.001
How often does the child wash hands or face before eating?		
Never	10.00 ± - (1)	1.00 ± - (1)
Rarely	3.90 ± 1.29 (10)	3.75 ± 2.06 (4)
Sometimes	6.54 ± 3.26 (35)	3.79 ± 1.81 (19)
Frequently	6.52 ± 5.38 (62)	2.78 ± 1.11 (18)
Always	6.73 ± 3.25 (117)	3.73 ± 2.47 (26)
p-value	.235	.320

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
How often does the child wash hands or face before going to sleep?		
Never	3.40 ± 1.67 (5)	-
Rarely	5.50 ± 3.14 (10)	-
Sometimes	6.59 ± 6.27 (29)	3.09 ± 1.92 (11)
Frequently	5.96 ± 2.86 (54)	3.41 ± 1.54 (17)
Always	6.94 ± 4.02 (128)	3.54 ± 2.18 (41)
p-value	.171	.806
How often does the child wash hands or face after playing with dirt or sand?		
Never	11.17 ± 11.70 (6)	1.00 ± - (1)
Rarely	6.00 ± 1.79 (6)	-
Sometimes	6.68 ± 2.761 (22)	3.27 ± 2.45 (11)
Frequently	6.29 ± 4.25 (45)	3.71 ± 2.40 (14)
Always	6.43 ± 3.36 (140)	3.44 ± 1.72 (43)
p-value	.065	.611
How often has the child used a pacifier in the last 6 months?		
Never	6.60 ± 4.03 (201)	3.26 ± 1.82 (61)
Rarely	4.40 ± 1.67 (5)	2.00 ± - (1)
Sometimes	6.74 ± 1.89 (4)	-
Frequently	5.00 ± 2.35 (5)	5.00 ± 1.41 (2)
Always	5.55 ± 3.62 (11)	4.75 ± 3.59 (4)
p-value	.681	.255
How often does the child suck their thumb or fingers?		
Never	6.53 ± 3.86 (162)	3.43 ± 2.08 (47)
Rarely	7.10 ± 2.84 (21)	2.50 ± .58 (4)
Sometimes	5.30 ± 2.72 (23)	3.80 ± 1.62 (10)
Frequently	7.27 ± 7.17 (11)	3.57 ± 2.51 (7)
Always	7.11 ± 4.57 (9)	3.00 ± - (1)
p-value	.516	.867
How often does the child chew on their fingernails?		
Never	6.90 ± 4.46 (131)	3.61 ± 2.06 (44)
Rarely	6.22 ± 3.36 (37)	3.20 ± 1.87 (10)
Sometimes	6.00 ± 2.64 (28)	3.13 ± 1.55 (8)
Frequently	6.05 ± 3.12 (21)	1.50 ± 0.71 (2)
Always	4.89 ± 1.62 (9)	3.60 ± 2.51 (5)
p-value	.435	.632
Does the child have a favorite blanket or toy?		
Yes	5.98 ± 3.09 (100)	3.44 ± 1.81 (34)
No	6.94 ± 4.44 (126)	3.43 ± 2.16 (35)
p-value	.066	.979

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
For those answering yes, how often does the child carry this around during the day?		
Never	5.43 ± 2.33 (23)	2.75 ± 1.26 (4)
Rarely	5.42 ± 2.97 (19)	3.00 ± 1.58 (5)
Sometimes	6.09 ± 3.75 (22)	3.90 ± 2.33 (10)
Frequently	5.88 ± 2.70 (25)	3.54 ± 1.81 (13)
Always	7.67 ± 3.80 (12)	2.33 ± 1.16 (3)
p-value	.294	.657
For those answering yes, how often does the child put this blanket or toy in their mouth?		
Never	5.90 ± 3.16 (52)	3.20 ± 1.48 (10)
Rarely	4.94 ± 2.56 (17)	3.40 ± 1.84 (10)
Sometimes	7.69 ± 3.59 (16)	2.67 ± 1.53 (3)
Frequently	6.14 ± 2.85 (7)	3.50 ± 2.67 (8)
Always	5.13 ± 1.64 (8)	4.00 ± 1.41 (4)
p-value	.111	.915
How often does the child put things other than food into their mouth?		
Never	5.97 ± 2.91 (34)	3.09 ± 1.64 (11)
Rarely	6.14 ± 3.09 (64)	3.17 ± 1.42 (18)
Sometimes	6.83 ± 4.59 (63)	3.71 ± 2.31 (17)
Frequently	7.91 ± 4.87 (35)	3.46 ± 2.76 (13)
Always	5.68 ± 3.60 (28)	3.43 ± 1.27 (7)
p-value	.119	.924
How often does the child put their mouth on furniture or on the window sill?		
Never	6.59 ± 4.13 (100)	3.08 ± 1.98 (25)
Rarely	6.22 ± 2.97 (49)	4.00 ± 2.32 (17)
Sometimes	6.60 ± 3.96 (48)	3.00 ± 1.41 (17)
Frequently	7.05 ± 5.36 (20)	4.00 ± 2.33 (8)
Always	6.00 ± 2.51 (8)	4.50 ± 0.71 (2)
p-value	.935	.383
How often does the child swallow things other than food?		
Never	6.29 ± 4.00 (170)	3.29 ± 2.11 (45)
Rarely	6.84 ± 3.20 (37)	3.50 ± 1.72 (18)
Sometimes	8.00 ± 4.85 (14)	4.20 ± 1.92 (5)
Frequently	7.75 ± 3.40 (4)	5.00 ± - (1)
Always	7.00 ± - (1)	-
p-value	.526	.661

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
How often does the child put paint chips in their mouth?		
Never	6.47 ± 3.97 (216)	3.45 ± 1.99 (65)
Rarely	6.25 ± 3.30 (4)	4.50 ± 2.12 (2)
Sometimes	7.50 ± 1.91 (4)	-
p-value	.868	.464
Does your household have a vegetable garden?		
Yes	6.64 ± 4.72 (66)	3.08 ± 1.83 (12)
No	6.44 ± 3.55 (159)	3.51 ± 2.02 (57)
p-value	.733	.503
For those with a vegetable garden, how often does the child eat vegetables grown in your garden?		
Never	4.79 ± 2.91 (14)	3.50 ± 2.17 (6)
Rarely	5.07 ± 1.77 (14)	3.00 ± - (1)
Sometimes	6.80 ± 3.47 (20)	4.00 ± 2.83 (2)
Frequently	8.41 ± 7.66 (17)	3.00 ± - (2)
Always	7.25 ± 3.50 (4)	2.33 ± 1.53 (3)
p-value	.184	.896
How often does the child eat vegetables grown elsewhere in the local area?		
Never	6.07 ± 3.11 (99)	4.00 ± 2.94 (13)
Rarely	6.35 ± 3.17 (40)	2.65 ± 1.04 (20)
Sometimes	6.48 ± 4.14 (54)	3.41 ± 1.99 (22)
Frequently	7.40 ± 3.87 (25)	4.00 ± 1.76 (10)
Always	10.80 ± 13.03 (5)	4.25 ± 1.71 (4)
p-value	.072	.224
Has the child ever been treated with traditional, folk, or herbal medications?		
Yes	6.73 ± 3.75 (15)	3.20 ± 2.05 (5)
No	6.43 ± 3.87 (209)	3.46 ± 2.01 (63)
p-value	.766	.781

Table 6. —(cont) Mean Blood Lead Values Compared to Questionnaire Factors by Group Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

FACTOR	STUDY Mean ± SD (n)	CONTROL Mean ± SD (n)
Amount of money spent on food per week in household:		
≤ $25	5.25 ± 2.99 (4)	1.00 ± - (1)
$25-$50	6.18 ± 2.87 (39)	3.00 ± 1.22 (17)
$50-$75	5.92 ± 3.53 (85)	3.65 ± 2.21 (26)
$75-$100	7.39 ± 4.61 (67)	4.00 ± 2.29 (17)
> $100	7.07 ± 4.31 (30)	3.00 ± 1.53 (7)
p-value	.157	.209

1. P-values for factors with two categories are from t-test, factors with more than two categories are from Analysis of Variance. All are two-tailed significance.
2. Results do not include responses of "don't know" or "refused". There were 98 such responses in the study group and 31 such responses in the control group.

Table 7. —Correlation Coefficients and Level of Significance for Questionnaire and Environmental Data with Blood Lead Levels in Study Group Big River Mine Tailings Superfund Site Lead Exposure Study, MO. 1997

Variable [1]	Correlation Coefficient	p-value[2]	Number of Children
Questionnaire			
Age	-.011	.866	226
How often[3] do you dry sweep	.157	.018	226
How often do you mop	.099	.138	226
How often do you wet wipe	.068	.310	226
How often do you dry dust	-.024	.716	225
How often child plays outdoors	.094	.158	226
How often child plays on grassy area	.101	.132	225
How often child plays on concrete/asphalt	.011	.868	224
How often child plays in dirt	.128	.056	225
How often child takes food outside	.152	.022	225
How often child takes pacifier outside	.018	.788	226
How often child washes hands before eating	.081	.266	225
How often child washes before sleeping	.135	.042	226
How often child washes after playing in dirt	-.116	.088	219
How often child used pacifier, last six months	-.035	.602	226
How often child sucks thumb	.003	.968	226
How often child chews fingernails	-.122	.066	226
How often child carries favorite toy around	.176	.078	101
How often child puts blanket/toy in mouth	.033	.746	100
How often child puts other things in mouth	.059	.382	224
How often child puts mouth on furniture or window sill	.006	.934	225
How often child swallow things other than food	.111	.098	226
Mother's highest level of education	-.191	.004	226
Money spent on food per week	.132	.048	225
Gross household income before taxes	-.277	.000	226
Environmental Samples			
Lead concentration in tap water	-.069	.300	226
Lead concentration in vacuum bag	.024	.736	195
Lead concentration in yard soil	.133	.046	224
Lead concentration in play area soil	.102	.134	216
Lead concentration found in the drip line soil	.217	.002	222
Lead loading in floor cassette vacuum	.377	.000	220
Lead concentration in floor cassette vacuum	.194	.004	225
Lead loading in window sill dust wipe	.319	.000	215
Observed visible soiling of dust wipe sampling material	.181	.008	218
XRF for all indoor surfaces	.357	.000	226
XRF >0 for indoor surfaces	.217	.002	185
XRF ≥0.7 for indoor surfaces	.074	.410	126
XRF for indoor friction surfaces only	.333	.000	226
XRF for indoor surfaces by room	.357	.000	226
XRF for indoor surfaces by room and friction	.345	.000	226
XRF for indoor friction surfaces only weighted[4] by d/t	.256	.012	98
XRF for indoor surfaces weighted by d/t by room	.245	.016	98
XRF for indoor surfaces weighted by d/t by room and friction	.366	.000	98
XRF for all outdoor surfaces	.232	.000	226
XRF >0 for outdoor surfaces	.068	.368	179
XRF ≥0.7 for outdoor surfaces	-.016	.850	144

1. Bolded variables have a significant correlation at the 0.10 level.
2. Two-tailed significance level.
3. All 'How often' questions utilized Likert scale of 1 (never) through 5 (always).
4. d/t = damaged area/total wall area. Contains only XRF values ≥0.7 mg/cm^2.

Table 8. —Correlation Coefficients and Level of Significance for Questionnaire and Environmental Data with Blood Lead Levels in Control Group Big River Mine Tailings Superfund Site Lead Exposure Study, MO. 1997

Variable[1]	Correlation Coefficient	p-value[2]	Number of Children
Questionnaire			
Age	-.091	.460	69
How often[3] do you dry sweep	-.106	.386	69
How often do you mop	.088	.474	69
How often do you wet wipe	-.187	.124	69
How often do you dry dust	-.181	.136	69
How often child plays outdoors	.103	.400	69
How often child plays on grassy area	.345	.004	69
How often child plays on concrete/asphalt	-.088	.474	68
How often child plays in dirt	.219	.070	69
How often child takes food outside	.077	.528	69
How often child takes pacifier outside	.081	.512	68
How often child washes hands before eating	.043	.728	68
How often child washes before sleeping	.078	.524	69
How often child washes after playing in dirt	.081	.510	69
How often child used pacifier, last six months	.219	.074	68
How often child sucks thumb	.031	.802	69
How often child chews fingernails	-.095	.436	69
How often child carrys favorite toy around	.039	.826	35
How often child puts blanket/toy in mouth	.104	.552	35
How often child puts other things in mouth	.075	.550	66
How often child puts mouth on furniture or window sill	.110	.370	69
How often child swallow things other than food	.144	.238	69
Mother's highest level of education	-.284	.018	69
Money spent on food per week	.153	.210	69
Gross household income before taxes	-.272	.024	69
Environmental Samples			
Lead concentration in tap water	.144	.238	69
Lead concentration in vacuum bag	.119	.374	58
Lead concentration in yard soil	.239	.048	69
Lead concentration in play area soil	.157	.240	58
Lead concentration found in the drip line soil	.131	.284	69
Lead loading in floor cassette vacuum	-.131	.300	64
Lead concentration in floor cassette vacuum	-.134	.292	64
Lead loading in window sill dust wipe	.104	.412	65
Observed visible soiling of dust wipe sampling material	.154	.206	69
XRF for all indoor surfaces	.112	.360	69
XRF >0 for indoor surfaces	.043	.754	55
XRF ≥0.7 for indoor surfaces	.179	.328	32
XRF for indoor friction surfaces only	.177	.146	69
XRF for indoor surfaces by room	.116	.344	69
XRF for indoor surfaces by room and friction	.174	.154	69
XRF for indoor friction surfaces only weighted[4] by d/t	-.279	.262	18
XRF for indoor surfaces weighted by d/t by room	-.203	.420	18
XRF for indoor surfaces weighted by d/t by room and friction	-.300	.228	18
XRF for all outdoor surfaces	.101	.406	69
XRF >0 for outdoor surfaces	.043	.754	55
XRF ≥0.7 for outdoor surfaces	.030	.846	44

1. Bolded variables have a significant correlation at the 0.10 or less level.
2. Two-tailed significance level.
3. All 'How often' questions utilized Likert scale of 1 (never) through 5 (always).
4. d/t = damaged area/total wall area. Contains only XRF values ≥0.7

Table 9. —Correlations Between Dust and Soil Lead Measures in the Study Area Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

		Lead Concentration in Floor Vacuum Cassette	Lead Loading in Window Sill Dust Wipe	Lead Concentration in Vacuum Bag
Lead Concentration in Drip Line Soil	Pearson Correlation Coefficient =	.048	.315	.130
	Two-tailed significance level =	.469	.000	.068
	Number of samples =	230	218	197
Lead Concentration in Play Area Soil	Pearson Correlation Coefficient =	.020	.026	.010
	Two-tailed significance level =	.764	.705	.888
	Number of samples =	221	209	192
Lead Concentration in Yard Soil	Pearson Correlation Coefficient =	.028	-.019	-.008
	Two-tailed significance level =	.667	.779	.912
	Number of samples =	232	219	199

Table 10. —Correlations Between XRF, Dust and Soil Lead Measures in the Study Area Big River Mine Tailings Superfund Sites Lead Exposure Study, Missouri 1997

		Lead Concentration In Vacuum Bag	Lead Concentration In Floor Vacuum Cassette	Lead Loading in Window Sill Dust Wipe	Lead Concentration In Drip Line Soil	Lead Concentration In Play Area Soil	Lead Concentration In Yard Soil
Unweighted Average XRF for Indoor Readings	Pearson Correlation Coefficient =	**.190**[1]	.070	**.405**[1]	**.388**[1]	.041	.111
	Two-tailed significance level =	.007	.285	.000	.000	.544	.091
	Number of samples =	201	234	221	231	222	233
Average of All XRF Outdoor Readings	Pearson Correlation Coefficient =	**.269**[1]	-.001	**.337**[1]	**.349**[1]	-.007	.014
	Two-tailed significance level =	.000	.989	.000	.000	.920	.827
	Number of samples =	201	234	221	231	222	233

1. Bolded correlations are significant at the 0.05 or less level.

Table 11. —Range and Median of Percent Contribution of Lead from Selected Sources[1] in the Study Area as Predicted from Modeled Classification Scheme Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997

	Waste Pile Source		Paint Source		Soil[2]		Common	
	WV	WVL	PV	PVL	SV	SVL	CV	CVL
Waste Piles	47.8%-95.6% (79.1%)[3]	22%-86.2% (69.4%)	0.2%-4.6% (3.4%)	0.2%-6.8% (4.7%)	--	--	3.9%-48.3% (16.3%)	13.6%-72.9% (26.8%)
Paint Chips	0%-5.3% (0.35%)	0-5.3% (0.3%)	9.7%-99.1% (82.25%)	12.8%-98.9% (85.65%)	--	--	0.8%-88.7% (15.85%)	1.0%-85.5% (13.85%)
Soils	58.5%	51%	0%	0%	--	--	41.5%	49.5%
Vacuum Bags	-8.1%-57.3%[4] (26.35%)	5.8%-60.1% (21.05%)	1.6%-80.3% (16.05%)	-1.2%-88.5% (23.15%)	0.4%-65.3% (36.84%)	-2.5%-18.9% (8.1%)	-2.7%-37.6% (14.7%)	-4.3%-75.5% (29.3%)

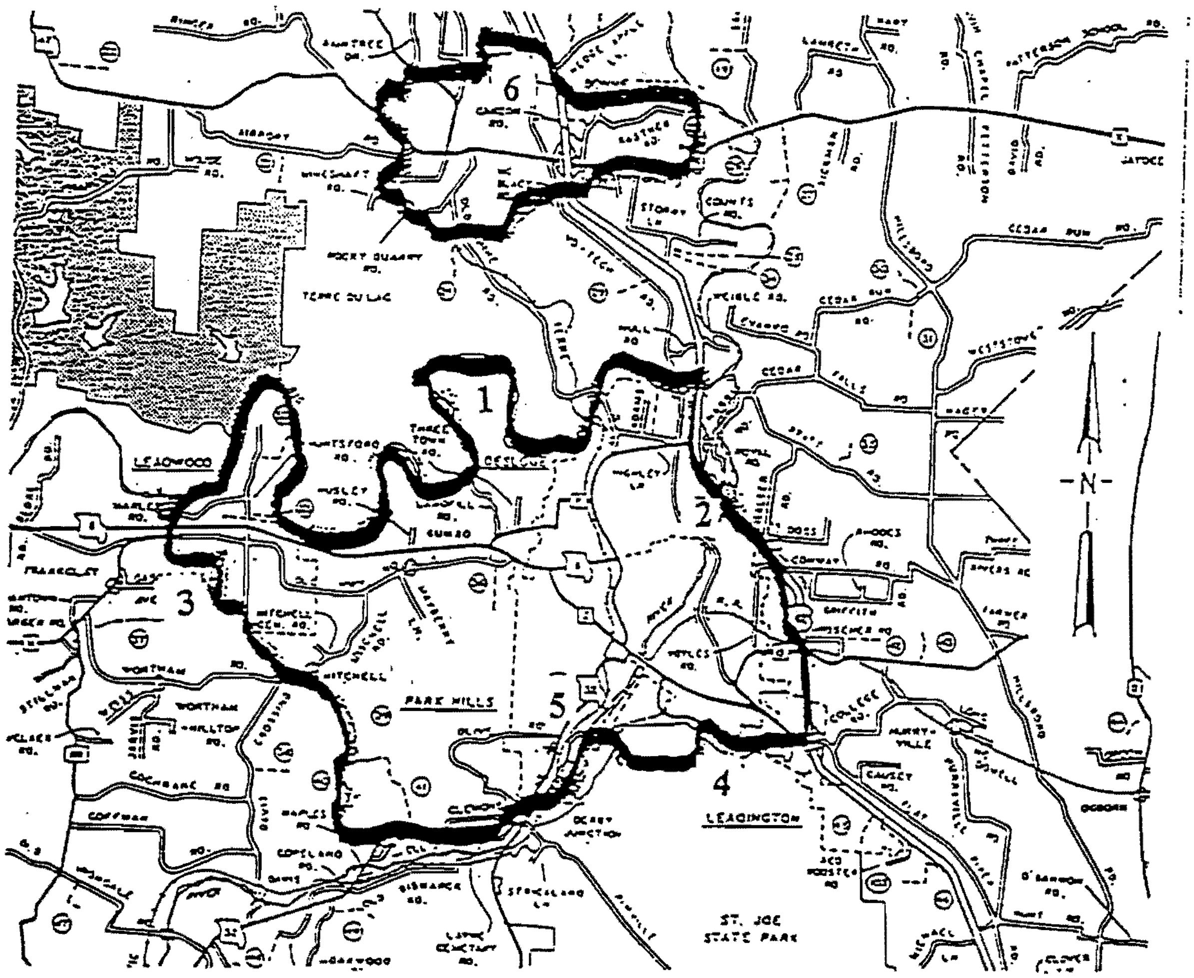
1. Lead sources are waste pile, paint, soil or common (cannot differentiate between the possible sources. The first level of the classification scheme developed weights the percent attributed to a source category based on the volume sum of the particles analyzed. These are identified as WV (Waste Volume), PV (Paint Volume), SV (Soil Volume), and CV (Common Volume). The second level additionally weights by the fraction of lead determined in each particle as shown by WVL (Waste Volume Lead), PVL (Paint Volume Lead), SVL (Soil Volume Lead), and CVL (Common Volume Lead).
2. Soil determination was only used for characterization of the study and control area samples.
3. Values in parenthesis represent median percentages.
4. The prediction model developed for the classification scheme uses a least squares apportionment method. Due to the nature of a model, negative entries are bound to occur, but they are all less than 10%. This suggests a reasonable prediction of potential sources.

FIGURES

Figure 1

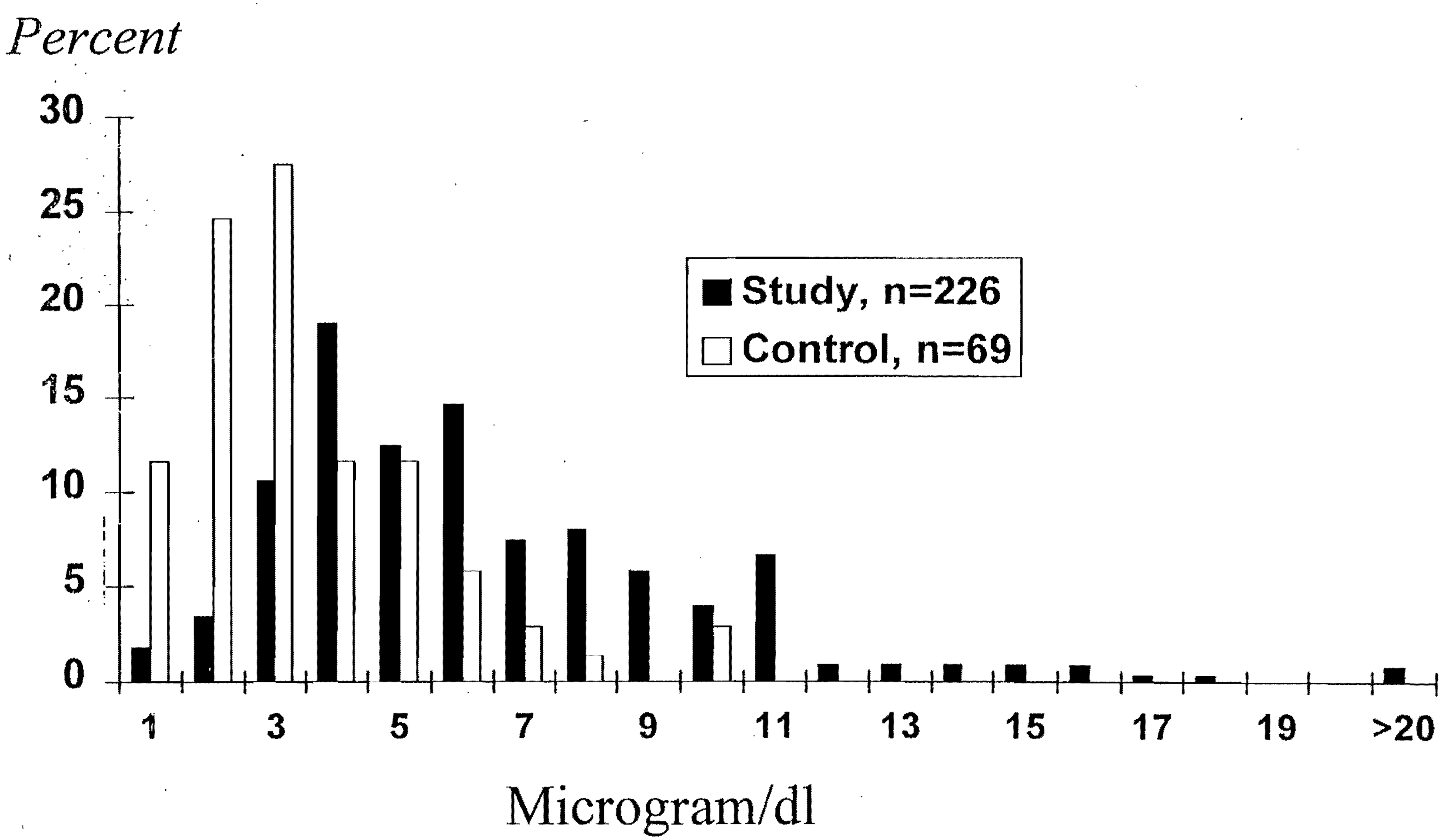
Study Area

Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri 1997



1. Big River Tailings Pile, 2. National Tailings Pile, 3. Leadwood Tailings Pile, 4. Federal Tailings Pile, 5. Elvins Tailings Pile, 6 Bonne Terre Tailings Pile

Figure 2: Blood Lead Levels for Study and Control Groups
Big River Mine Tailings Superfund Site Lead Exposure Study, Missouri, 1997



APPENDICES

Appendix 1: Questionnaire

BIG RIVER MINE TAILINGS SUPERFUND SITE
LEAD STUDY

QUESTIONNAIRE

DATE: Month:______Day:________Year:_______
INTERVIEWER:______________________________

NAME OF RESPONDENT:______________________
CHILD'S NAME:______________________________

SECTION I: HOUSEHOLD CHARACTERISTICS

The following questions must be answered by the parent or legal guardian of the child. **Circle applicable answer.**

1. Who is answering these questions?

   1=child's mother
   2=child's father
   3=child's grandparent
   4=child's other relative
   5=other ____________
   8=refused

First, I would like to ask you some questions about the home *child's name* lives in. *Where child has lived most of the time in the last 90 days.*

2. What year was this house built? *Oldest part*

00=≤1900-1909	06=1960-1969
01=1910-1919	07=1970-1979
02=1920-1929	08=1980-1989
03=1930-1939	09=1990-present
04=1940-1949	88=refused
05=1950-1959	99=don't know

3. Is the home *child's name* lives in rented or owned?

1=rented
2=owned
3=other__________
8=refused
9=don't know

4. What type of water pipes does your home contain?

1=lead	6=mixed, specify__________
2=plastic	7=other, specify__________
3=galvanized steel	8=refused
4=copper	9=don't know
5=iron	

5. What is the source of water to your house?
Circle one per column

	Drinking	Cooking
Public water	1	1
Well	2	2
Other __________	3	3
Refused	8	8
Don't know	9	9

6. What type of water does *child's name* normally use for

	Drinking	Cooking
Public water	1	1
Well	2	2
Bottled	3	3
Refused	8	8
Don't know	9	9

7. Is the water in your kitchen faucet filtered or treated?

1=Yes
2=No
8=Refused
9=Don't Know

8. Has any part of your house been repainted, sanded, or stripped chemically or by heat, within the last year? *If NO, go to question 9*

1=Yes
2=No
8=Refused
9=Don't Know

8a. *If YES*, approximately when was this most recently done?

___ ____ / ____ ______
Month Year (Enter 99 if respondent doesn't know months)
8=Refused

8b. And in what part of the house was the work done?
(Circle all that apply)

1=bedroom?
2=living room?
3=bathroom?
4=kitchen
5=outside walls?
6=porch?
7=deck?
8=refused
9=other __________________

9. How often do you use air conditioning the summer?
If NEVER, go to question 10.

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

9a. And where is your air conditioning used? (circle all that apply)

central?	1
living/familiy room	2
child's bedroom	3
other bedroom	4
kitchen	5
refused	8
other __________________	

10. Has anyone ever used any materials from mines or smelters, such as chat or slag, or lead industry material in or around your house or yard?

1=Yes
2=No
8=Refused
9=Don't know

11. Do you have any pets that go in and out of the house?

1=Yes
2=No
8=Refused
9=Don't know

SECTION II: ENVIRONMENTAL SOURCES

Next I have some questions about a number of activities you or other household members may do or may have done in the last three months. These include things you may have done for work, hobbies, or chores at home or at another place.

12. In the last 90 days, have any members of your your household: (Circle all that apply)					12a. IF YES: Was this done at home, work, or elsewhere?					12b. IF WORK/OTHER: Were those clothes worn home?				Did he/she shower before coming home?			
	Yes	No	Refused	Don't know	HOME	Work/ OTHER	BOTH	Refused	Don't know	Yes	No	Refused	Don't know	Yes	No	Refused	Don't know
a. Painted pictures with artists paints? (not children's paints)	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
b. Painted, stained or refinished furniture?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
c. Painted the inside or outside of a home or building?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
d. Work with stained glass?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
e. Cast lead into fishing sinkers, bullets or anything else?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
f. Worked with soldering sheets of metal?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9

2. In the last 90 days, have any members of your your household:
(Circle all that apply)

12a. IF YES:

12b. IF WORK/OTHER:

					Was this done at home, work, or elsewhere?					Were those clothes worn home?				Did he/she shower before coming home?			
	Yes	No	Refused	Don't know	HOME	Work/ OTHER	BOTH	Refused	Don't know	Yes	No	Refused	Don't know	Yes	No	Refused	Don't know
g. Soldering pipes or sheets of metal?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
h. Repaired auto radiators?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
i. Worked on auto bodies or auto maintenance? (includes mechanics)	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
j. Worked at a sewage treatment plant?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
k. Made pottery?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
l. Ridden a dirt bike, mountain bike or ATV in the local area?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
m. Welding?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
n. Cleaned or repaired firearms?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
o. Visited indoor firearm target ranges?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9

12. In the last 90 days, have any members of your your household:
(Circle all that apply)

12a. IF YES:

12b. IF WORK/OTHER:

					Was this done at home, work, or elsewhere?					Were those clothes worn home?				Did he/she shower before coming home?			
	Yes	No	Refused	Don't know	HOME	Work/ OTHER	BOTH	Refused	Don't know	Yes	No	Refused	Don't know	Yes	No	Refused	Don't know
p. Wire/cable cutting or splicing?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
q. Casting or smelting lead?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
r. Plastics manufacture?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
s. Battery manufacture?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
t. Pipe machining?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
u. Electroplating with lead solutions?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
v. Refining gasoline?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
w. Paint, glaze, and ink? manufacture?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
x. Rubber manufacture?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
y. Scrap metal recovery?	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9
z. Other lead related job or activity? SPECIFY ____________	1	2	8	9	3	4	5	8	9	1	2	8	9	1	2	8	9

Now I'd like to ask you some questions about the mine-related persons living in this home.

13. Have any people living in this house worked in mining or a mining related job such as material handling or transportation in the last 90 days?

1=Yes
2=No (If no skip to question 18)
8=Refused
9=Don't know

14. What type of mining or mine related work was done?

	YES	NO	Refused	Don't know
a. Underground	1	2	8	9
b. Surface	1	2	8	9
c. Milling	1	2	8	9
d. Transportation/ handling	1	2	8	9
e. Clerical/Admin.	1	2	8	9
f. Smelter	1	2	8	9
g. Other	1	2	8	9

*If Other, specify*____________________

15. What type of mine materials were worked with? *Circle all that apply.*

	YES	NO	Refused	Don't know
a. Lead	1	2	8	9
b. Zinc	1	2	8	9
c. Silver	1	2	8	9
d. Molybdenum	1	2	8	9
e. Coal	1	2	8	9
f. Limestone	1	2	8	9
g. Clay	1	2	8	9
h. Other	1	2	8	9

*If Other, specify*____________________

16. Does this person wear *his/her* clothes home after working?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

17. Does this person come home from work without showering?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

SECTION III: BEHAVIORAL FACTORS

Now I'd like to ask you some questions about your **diet and food preparation.**

18. When food or drinks are prepared, served, or stored, how often are they placed in clay pottery or ceramic dishes which were homemade or made in another country?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

19. When food or drinks are prepared, served or stored, how often are they placed in copper or pewter dishes or containers?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

20. When food or drinks are stored or put away, how often are they stored in the original can after being opened?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

21. How often do you **vacuum**?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

21a. How often do you **dry sweep**?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

21b. How often do you **mop**?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

21c. How often do you **wet wipe**?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

21d. How often do you **dry dust**?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

21e. How often do you use **other house cleaning methods?** *Specify*__________

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

22. How often do you clean the following rooms?

	times per month	how long each time *(in minutes)*
kitchen	________	________
child's bedroom	________	________
living/family room	________	________

23. Do you have a vacuum cleaner? *If No, go to 24*

1=yes
2=no
8=refused
9=don't know

23a. How long ago was the vacuum cleaner last used? ____________*(days)*

23b. How long ago was the vacuum cleaner bag emptied or last changed?______*(days)*

Now I have a few other questions about **smoking** in your household.

24. Does anyone smoke tobacco products in *your* home?
Circle responses. (1 pack = 20 cigarettes).

1=Yes
2=No (If no skip to question 26)
8=Refused
9=Don't know

25. How many people smoke in this house? Include regular visitors/baby-sitters.

________ number of people
8=refused
99=don't know

Participant Child Questionnaire

Now I need to ask a number of questions about *child's name*.

26. How long has *child's name* been living in this home?

    Years ____ _____
    Months ____ _____

    If less than 90 days, obtain previous address.

    ____

    ____

27. What is *child's name* date of birth?

    (MO/DA/YR.) ____/____/_____

    88=refused
    99=don't know

28. Is *child's name* a boy or girl?

    1=boy 2=girl

29. Which of the following best describes *child's name* racial background?

    1=Black
    2=White
    3=Asian or Pacific Islander
    4=American Indian/Alaska native
    8=Refused
    9=Don't know

30. *If response to question 29 is Black or White*, is *child's name* Hispanic?

    1=Yes
    2=No
    8=Refused
    9=Don't know

If child is two years old or younger, ask questions 31, 32, and 33.

31. Does *child's name* currently breast feed?

1=Yes (If yes skip to 33)
2=No
8=Refused
9=Don't know

32. *If response to above question is NO,* **was** *child's name* breast-fed?

1=Yes ______ *If YES*, for how long?______
2=No ______
8=Refused
9=Don't know______

33. Does the *child's name* currently take a bottle?

1=Yes
2=No
8=Refused
9=Don't know

34. How many hours during the day does *child's name* usually spend playing **on the floor** when he or she is **in this house**?

________Hours (88=refused) (99=don't know)

35. How often does *child's name* **play outdoors**?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

36. *If YES*, then how many hours a day on the average does *child's name* play outdoors?

__________Hours (88=refused) (99=don't know)

37. Where does *child's name* usually play when outside this house?
Circle one.

1=Back yard	7=Other (specify) ____________
2=Front yard	8=Refused
3=Side yard	9=Don't know
4=Street or side walk	

38. When *child's name* is not playing around the house? where does *he/she* usually play? *Circle one.*

1=Neighbor's yard
2=Playground
3=Near or around creek or ditch
4=On or near sidewalks or streets
5=Park
6=Only plays around the home
7=Other (Specify) ______________________
8=Refused
9=Don't know

39. How often does *child's name* play on a **grassy** area?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

40. How often does *child's name* play on **concrete/asphalt**?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

41. How often does *child's name* play in **dirt**?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

42. Is there any park or common play areas where the *child's name* plays?

1=Yes
2=No
8=Refused
If yes indicate where the area is located ______________________.

43. Does *child's name* crawl?=1, or walk?=2, or both?=3

44. How often does *child's name* take food, snacks, or candy outside to eat?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

45. How often does *child's name* take a bottle or pacifier outside with *him/her*?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

46. How often does *child's name* wash hands or face before eating?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

47. How often does *child's name* wash hands or face before going to sleep?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

48. How often does *child's name* wash hands or face after playing with dirt or sand?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

49. How many times is *child's name* bathed or given a shower per week?

____________ per week (88=refused) (99=don't know)

50. How often has *child's name* used a pacifier in the last 6 months?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

51. How often does *child's name* suck *his/her* thumb or fingers?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

52. How often does *child's name* chew on *his/her* fingernails?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

53. Does *child's name* have a favorite blanket or toy? *If NO, go to question* 56

1=yes
2=no
8=refused
9=don't know

54. How often does *child's name* carry this around during the day?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

55. How often does *child's name* put this blanket or toy in his/her mouth?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

56. How often does *child's name* put things **other than food** into *his/her* mouth?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

57. How often does *child's name* put *his/her* mouth on furniture or on the window sill?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

58. How often does *child's name* **swallow** things other than food?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

*Specify items swallowed*______________________

59. How often does *child's name* put paint chips in his/her mouth?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

60. Does your household have a vegetable garden?
If NO, go to question 62

1=Yes
2=No
8=Refused
9=Don't know

61. How often does *child's name* eat vegetables grown in your garden?

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

62. How often does *child's name* eat vegetables grown elsewhere in the local area? (*neighbor's garden or local farmer's market*)

never	1
rarely	2
sometimes	3
frequently	4
always	5
refused	8
don't know	9

63. Has *child's name* ever been treated with traditional, folk, or herbal medications?

1=Yes
2=No
8=Refused
9=Don't know

If yes, what was the medicine called?____________________________

SECTION IV: DEMOGRAPHIC AND SOCIOECONOMIC FACTORS

64. How many people live in this house? No.___________

64a. Could you tell me their **names** and **ages**, and their **relationship** to *child's name*?

NAME	AGE	RELATIONSHIP	*(relationship categories)*
			Mother
			Father
			Siblings
			Grandparents
			Other
			Refused
			Don't know

65. What is the highest year of education that was completed by the **mother** of this child? *Circle one.*

No schooling	1
Elementary School	2
High School(Ged=o12)	3
Technical or Trade School	4
Junior/Community College	5
Four Yr. College/University	6
Attended Graduate School(higher)	7
Refused to answer	8
Don't know	9

66. What is the number that corresponds to the amount of money spent on food per week in this houshold?

01=$25 or less
02=$25 to $50
03=$50 to $75
04=$75 to $100
05=more than $100
08=Refused
09=Don't know

67. What number corresponds to the total, gross household income before taxes?

01=\$4,999 or less	07=\$30,000 to 34,999
02=\$5, 000 to \$9,999	08=\$35,000 to \$39,999
03=\$10,000 to \$14,999	09=\$40,000 to more
04=\$15,000 to \$19,999	88=Refused to answer
05=\$20,000 to \$24,999	99=Don't know
06=\$25,000 to \$29,999	

End: This completes the questionnaire. Do you have any questions or comments about it?

____

____

____

Thank you very much for your time.

Appendix 2: Release and Consent Forms

MISSOURI DEPARTMENT OF HEALTH

Mel Carnahan
Governor

Coleen Kivlahan, M.D., M.S.P.H.
Director

P.O. Box 570, Jefferson City, MO 65102-0570 • 314-751-6400 • FAX 314-751-6010

RELEASE OF MEDICAL INFORMATION TO PARTICIPANT'S PHYSICIAN

BIG RIVER MINE TAILINGS SUPERFUND SITE AND SURROUNDING AREA BLOOD LEAD & ENVIRONMENTAL EXPOSURE STUDY

I understand that medical information about me has been and/or will be collected during the lead exposure study. I request that this information be released to my physician to assist him/her in providing any necessary medical advice and care.

Participant	Physician
Name (Please print)	Name (Please print)
Signature	Street
Date	City State Zip

MISSOURI DEPARTMENT OF HEALTH

Mel Carnahan
Governor

Coleen Kivlahan, M.D., M.S.P.H.
Director

P.O. Box 570, Jefferson City, MO 65102-0570 • 314-751-6400 • FAX 314-751-6010

REQUEST FOR PARTICIPANT REIMBURSEMENT

BIG RIVER MINE TAILINGS SUPERFUND SITE AND SURROUNDING AREA BLOOD LEAD & ENVIRONMENTAL EXPOSURE STUDY

I understand that I will be paid $15.00 by mailed check for agreeing to participate in the lead exposure study and that this will be the only monetary reimbursement I will receive. My name and mailing address are:

Printed Name ____________________ Street ____________________

Signature ____________________ City ____________ State ____ Zip ____

Date ____________________

MISSOURI DEPARTMENT OF
HEALTH

Mel Carnahan
Governor

Coleen Kivlahan, M.D., M.S.P.H.
Director

P.O. Box 570, Jefferson City, MO 65102-0570 • 314-751-6400 • FAX 314-751-6010

Participant Consent to Environmental Sampling In and Around Home

I understand that the health department's lead exposure study will include some environmental sampling in and around the homes of the participants. The sampling will include drinking water, vacuum bags, household dust, interior and exterior paint, and yard soil. The samples will be taken by St. Francois County Health Department and they will carry and show identification.

If my home is selected for sampling, I will allow reasonable access to properly identified representatives/contractors. I understand there will be no cost to me for this sampling and that I will be notified of the results. Prior to any sampling I will be contacted by phone for the arrangement of a convenient date and time.

Printed name ____________________

Signature ____________________

Today's Date ____________________

Address ____________________

Daytime Phone ____________________

Nighttime Phone ____________________

Directions to home ____________________

MISSOURI DEPARTMENT OF HEALTH

Mel Carnahan
Governor

Coleen Kivlahan, M.D., M.S.P.H.
Director

P.O. Box 570, Jefferson City, MO 65102-0570 • 314-751-6400 • FAX 314-751-6010

RELEASE OF MEDICAL INFORMATION TO DENT COUNTY HEALTH DEPARTMENT

BIG RIVER MINE TAILINGS SUPERFUND SITE AND SURROUNDING AREA BLOOD LEAD & ENVIRONMENTAL EXPOSURE STUDY

I understand that medical information about me has been and/or will be collected during the lead exposure study. I request that this information be released to the Dent County Health Department to assist in providing any necessary follow-up.

Participant

____
Name (Please print)

____
Signature

____
Date

CONSENT FOR PARTICIPATION IN RESEARCH ACTIVITIES: DESLOGE/BIG RIVER MINE TAILINGS SUPERFUND SITE BLOOD LEAD STUDY

This study is intended to determine if children living near the Desloge/Big River Superfund Site have higher blood lead levels than children not living in the area. The research study is being conducted by St. Louis University School of Public Health in cooperation with the Missouri Department of Health, St. Francois County Department of Health, U. S. Environmental Protection Agency, and Agency for Toxic Substances and Disease Registry.

Investigators on this study and their telephone numbers are:

Ana Maria Murgueytio, MD, MPH, Assistant Professor	314-977-8134
Gregory Evans, Ph.D., Associate Professor	314-977-8133
David Sterling, Ph.D., Assistant Professor	314-977-8123

Drs. Murgueytio, Evans, and Sterling have requested my participation in this research study: Desloge/Big River Mine Tailings Superfund Site Blood Lead Study. I understand that the purpose of this research is to investigate childhood lead poisoning in the communities near the Big River Mine Tailings Superfund Site as well as various environmental, behavioral, demographic, sociocultural, and economic factors as they relate to blood lead levels of children in communities near the Superfund site, compared to blood lead levels of children living in an area distant to the Superfund site. My participation will involve answering a questionnaire, allowing my child to provide blood for laboratory analysis, and to allow the investigators to take samples of the soil and dust in my home for laboratory analysis. My participation will also include allowing the investigators to take samples of soil from my yard around my home. The participation is an one time event and should involve approximately 2 1/2 hours of my time. I understand that the risks for my child, if I agree on his/her participation in the study, are minor discomfort for the blood drawing and probably bruising in the area of the needle stick. I understand that if discomforts do occur the investigators will try to minimize them as appropriate.

I understand that the information collected will be evaluated by the investigators and in cooperation with the other state and federal agencies. I understand that the results of the research study will be published, but that my and my child's identity will not be revealed and that the records will remain confidential. In order to maintain confidentiality, Drs. Murgueytio, Evans, and Sterling will not use my name, my child's name or our personal identifying information, and that other forms used for this study will be kept along with the results in a locked file cabinet.

I understand that the possible benefits of my child's participation in the research is that, if elevated blood lead levels are determined, my child will be referred for further follow-up and environmental assessment by an appropriate public health agency. The results might also be important to the design of future studies to develop appropriate interventions to help my child or other children with elevated blood lead levels.

I understand that my child's participation is voluntary and that refusal to participate will involve no penalty to me or my child, or loss of any benefits to which my child is otherwise entitled. I understand that I may withdraw my child's participation in the research study at any time without penalty or prejudice. Specifically, I understand that I need not answer any questions

asked by the Investigators if I do not wish to, and that I can stop my child's participation at any point without needing to give a reason. Since participation is voluntary, I understand that I or my child will not be charged for any part of this research project or for the services provided, and that an alternative to this study is not to participate. To the best of my knowledge, my child is not participating in any other medical research study.

Any questions that I may have concerning my child's participation in this research study will be answered by Dr. Ana Maria Murgueytio, Dr. Gregory Evans, or Dr. David Sterling, whose telephone numbers are listed above for my contact. I understand I will be compensated with a small amount of money by the University for my child's participation. If I have any questions about my child's rights as research participants or in the event I believe my child has suffered an injury as a result of participation in the research project, I may contact the Chairperson of the St. Louis University Institutional Review Board at 314-577-8108, who will review the matter with me, identify other resources that may be available to me, and provide further information as to how to proceed.

I have read the above statement and have been able to ask questions and express concerns, which have been satisfactorily answered by the investigators. I believe I understand the purpose of the study as well as the potential risks and benefits that are involved. I hereby give my informed and free consent for my and my child's participation in this study.

Date ____________________
Month/Day/Year

Parent/Guardian Signature ____________________________________

Parent/Guardian Name (Printed) ____________________________________

Witness Signature ____________________________________

Witness Name (Printed) ____________________________________

I certify that I have explained to the above individual(s) the nature and purpose of this research study, the potential benefits and possible risks associated with participation, have answered any questions that have been raised, and have witnessed the above signature.

These elements of informed consent conform to the assurance given by St. Louis University to the Department of Health and Human Services to protect the rights of persons who participate in research studies. I have provided the participant with a copy of this signed consent document.

Date ____________________
Month/Day/Year

Investigator Signature ____________________________________

Appendix 3: Media Information

lealth officials start blood study
vith phone calls to area residents

By Renee' Jean
Daily Journal Staff Writer

ione calls from the St. Francois nty Health department to about 0 households in Park Hills, dwood, Bonne Terre, East ne Terre and surrounding areas start Thursday, according to of- ıls with the health department.

'ary Bertram, Environmental itarian with the health depart- ıt, said the phone calls will es- lish an accurate census of seholds for an upcoming blood- l study to be conducted in areas /n-wind of mine tailings piles in Francois County.

'he study, conducted under the pices of the Missouri Depart- nt of Health, will gather informa- n about elevated blood-lead els found in some St. Francois unty children.

According to statistics, between and 30 percent of children par- ipating in the well-baby clinic and C programs have had higher than rmal levels of lead in their od-stream over the past two years. Both programs serve lower income families.

The source of the elevated levels is currently unknown, according to Bertram, who said that contributing factors range from old pipes to how often a family dusts. County-wide statistics on blood-lead levels are not currently available.

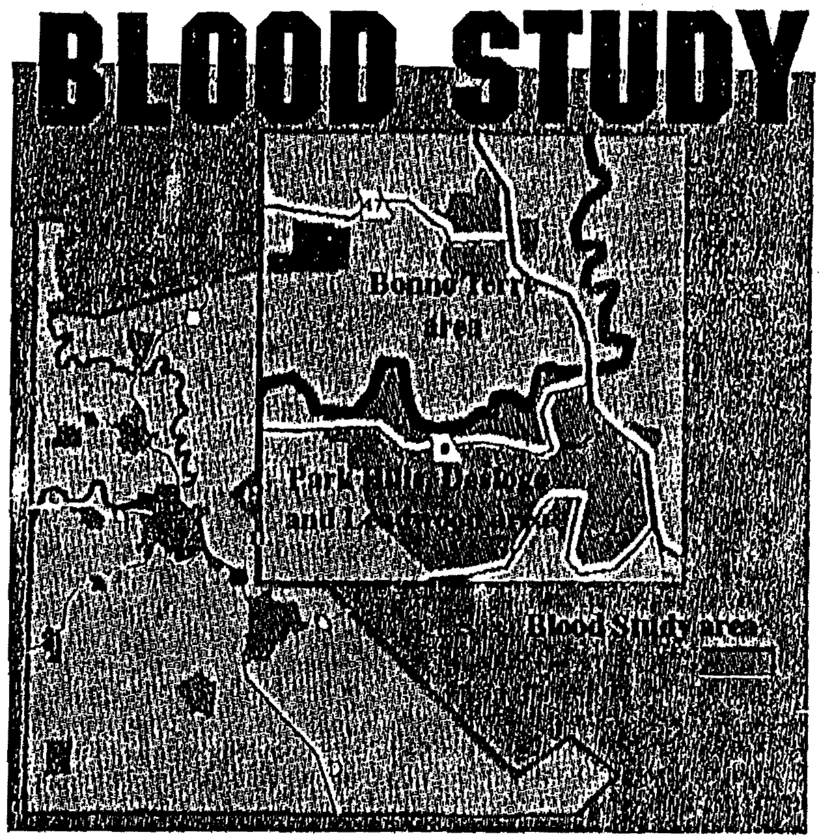
Census workers, who are from Mineral Area College or the St. Francois County Health Department will clearly identify themselves on the phone, Bertram said.

The census-takers will gather information about the number of residents living in the households, the number of children under six, the address of the resident and the age of the house.

Those households with children under six will be contacted to participate in the voluntary blood-lead study, Bertram said.

Results of the study will be used to make recommendations to the Department of Natural Resources and to help residents reduce the

(See BLOOD, page 3)



Blood

(Continued from page

likelihood of exposure to l cording to Brian Quinn, a man for the Missouri Depar Health.

Childhood exposure to l cause decreased intellige paired neural develo decreased growth, hearin and ability to maintain a st ture, Bertram said.

For more information a lead study, contact the Department of Health, B Environmental Epidemiolo Box 570, Jefferson City, M or call toll-free at 800/392-

Lead-exposure census takers to open study

By Renee' Jean
Daily Journal Staff Writer

Census takers gathering background information for an upcoming lead-exposure study in St. Francois County will begin door-to-door surveys Saturday in Bonne Terre and Desloge, health department officials reported today.

Response to the census has not been as smooth as officials would like, with some residents refusing to provide information, but officials say they are confident they will reach optimum participation levels in both study and control areas.

The lead-exposure study will gather information on blood-lead levels of St. Francois County children in Bonne Terre, Terre Du Lac, Desloge, Leadington, Park Hills, Leadwood and Mitchell. That study will not begin until census information is completed.

Officials want to have at least 250 children aged six months to six years participate in the upcoming study in St. Francois County.

"We hope people will realize that this part of the study is just intended to gather accurate population data and to identify potential study participants. Answering census questions doesn't obligate anyone to be in the upcoming blood-lead study," said Gary Bertram, environmental sanitarian with the St. Francois County Health Department.

Questions from census takers are mainly designed to determine potential study participants, whose parents will be contacted at a later time about.

Questions include name, age, sex and number of children living in the home, as well as the length of residency.

A mirror-image census is currently under way in Salem, an area chosen because of similarities to the study area in St. Francois County.

Salem has no mining history, but other factors are similar, including socio-economic make-up, population and houses of similar age and type, according to officials with the Missouri Department of Health.

Calls to Salem residents started today and health officials said they want to have a group of at least 150 children participate. Blood and environmental samples will eventually be taken in that area, with about the same time-frame as that in St. Francois County.

The control group is crucial to the outcome of the study because data

(See STUDY, page 2)

gained there will be used as a baseline of comparison for blood-lead data gathered in St. Francois County.

The purpose of the lead-exposure study is to evaluate environmental and other factors that have led to elevated blood-lead levels in some St. Francois County children.

According to statistics, between 25 and 30 percent of children participating in the well-baby clinic and WIC programs have had higher than normal levels of lead in their blood-stream over the past two years. Both programs serve lower income families.

The source of elevated lead levels is currently unknown, according to officials. In previous interviews Bertram said contributing factors range from old pipes to how often a family dusts.

Environmental factors that could contribute to elevated lead levels will also be considered in the study, which will make recommendations about lowering the levels to the Department of Natural Resources.

Childhood exposure to lead may cause decreased intelligence, impaired neural development, decreased growth and hearing acuity and inability to maintain a steady posture.

For more information about the study contact the Missouri Department of Health, Bureau of Environmental Epidemiology at 1-800 392-7245.

Appendix 4: Residential Canvass Guidance

Missouri Department of Health
Big River Area Lead Study
Residential Census Guidance

Background Information

The Missouri Department of Health (DOH) will conduct a study to determine whether the lead tailing piles in the Park Hills and Bonne Terre areas may be affecting the health of local residents. The study will focus on children between six months and six years of age since they are at higher risk for lead exposure.

Prior to the study, a census of residents in the study area and a comparison area will be conducted. Salem, Missouri will serve as the comparison area since it is demographically similar to the study area.

Census Description

Information: Using the "Household Census Forms"

- How many people live at the residence .
- For those six years old and younger, what are their names, birthdates (or age), sex, race, and time at the residence.
- Age of the home.
- Address and phone numbers.

Method

- Call if you have the phone number.
- Visit the homes that you don't have phone numbers for.
- If you get no answer, or if nobody is home, call or return to the home on a different day of the week at a different time of day.
- If you cannot get a response from a home, ask a neighbor.
- Document every attempt you make on the census form.

Safety

- Wear a visible picture I.D.
- Do not visit or call after 8:30 p.m.
- Stay on sidewalks and avoid walking through the yards.
- Respectfully decline an invitation to go inside the home.

- If a person is hostile, do not argue with them.

Other Important Tips

- If a resident refuses, politely try to find out why.
- If a resident questions who you are, what you are doing, or wants more information on lead exposure, refer them to:

Gary Bertram
St. Francois County Health Department
(314)431-1947

Always be pleasant and smile.

Sample Introduction

Hello, I am (your name) from Mineral Area College. We are working with the Missouri Department of Health conducting a census of your neighborhood for a future study. May I ask you a few questions? It will only take a moment.

Appendix 5: Household Census Form

Missouri Department of Health

Household Census Form

Big River Blood Lead Exposure Study, Missouri

Interviewer # ________

Telephone Call Number 1 2 3 4 5 6 7 8 9 ≥10 (Mark an "X" on each number that applies.)

Date/Time 1 ________ Date/Time 2 ________ Date/Time 3 ________

Date/Time 4 ________ Date/Time 5 ________ Date/Time 6 ________

Date/Time 7 ________ Date/Time 8 ________ Date/Time 9 ________

Date/Time 1 0________

Visit Number 1 2 3 4 5 6 7 8 9 ≥10 (Mark an "X" on each number that applies)

Date/Time 1 ________ Date/Time 2 ________ Date/Time 3 ________

Date/Time 4 ________ Date/Time 5 ________ Date/Time 6 ________

Date/Time 7 ________ Date/Time 8 ________ Date/Time 9 ________

Date/Time 1 0________

Name of Responder ____________________

1. How many members in this household? (Circle number)

0 1 2 3 4 5 6 7 8 9 ≥10

2. What is your relationship in this household?______ (1- Parent; 2- Child; 3- Other family member; 4- Other)

3. What are the names, dates of birth, ages, sexes, race, and length of residence of persons in the household between ages 0 and 72 months of age? (List below)

First and Last Name (0-72 Months)	Date of Birth	Age (opt)*	Sex	Race	Time at Residence

* If no date of birth is available.

PRINT

Residential Address ____________________ (Street, R. R., Box #) City ____________

Telephone (Home) ____________ (Work) ____________ (Responder) Zip code ____________

Mailing Address(If different) ____________________ (Street, R. R., Box #)

City ____________ Zip code ____________

What is the age of this house (years)? ________

Appendix 6: Recruitment Letter From St. Francois County Health Department

St. Francois County Health Center

1025 West Main
P.O. Box Q
Park Hills, Missouri 63601

(573) 431-1947
FAX 431-7326

Jane C. Hartrup, R.N., B.S.
Administrator

Jon L. Peacock
Environmental Sanitarian III

Counties Served:
Iron
Madison
St. Francois
& Ste. Genevieve

To St. Francois County Parents: August 28, 1995

Lead may be found in the soil in your yard. It also may be in the paint on your home. Sometimes lead may be found in the dust in your home or even in the water you drink.

Lead is most dangerous to children. It can hurt them without you knowing it. Even tiny amounts of lead are bad. It can harm their brain and change the way they think and act. Large amounts of lead can cause serious injury or death.

We are trying to find out how much your child has been exposed to lead. Only 250 homes will be tested in St. Francois County. Your home has been chosen to be tested for lead. You will be contacted by a health department worker. They will either call or stop by your home. When you are contacted, please let them know if you would like to have your home tested.

If you are interested, someone will contact you at a later date and set up a time that is good for you to have your home tested. The testing will include:

* the soil from your yard,
* the dust in your home,
* the paint on your house, and
* the water in your home.

We will also test one of your children under the age of 6 for lead. A nurse will take a small blood sample from your child.

These tests will all be done at your home and will take about 2 hours. This will tell you if your child is being poisoned by lead in your home.

Thank you,

Jane Hartrup, R.N.

Administrator

Appendix 7: Study Area Recruitment

Free Lead Testing Available for Bonne Terre, Park Hills, Desloge, and Leadwood Homes With Children 6 Months to 6 Years Old

Lead can cause serious health problems. It is especially harmful to children. Lead exposure of your child may cause:

* Learning Problem
* Behavioral Problems
* Coordination Problems
* Speech and Language Problems
* Poor Hearing
* Poor Muscle and Bone Growth

The Missouri Department of Health and Saint Louis University are conducting lead testing in Bonne Terre, Park Hills, Desloge, and Leadwood. Lead may be found in the dirt in your yard, paint on your home, or in the water you drink. Testing of homes in the area has already begun and will end within the next two weeks. You are eligible to have your home tested for lead if:

1. **You live in the city limits of Bonne Terre, Park Hills, Desloge, or Leadwood. (Any dwelling including mobile homes and apartments)**
2. **You have lived in your home for at least 90 days.**
3. **You have a child in the home between 6 months and 6 years of age.**

The testing takes about two hours and is done for free. It includes soil from your yard, dust in your home, paint on your house, and water in your home. It also includes a blood test for your child under the age of 6. A nurse will take a small sample from your child during the visit. There is a questionnaire that will be conducted with the parent or guardian of the child. These tests will tell you if your child is being poisoned by lead in or around your home. In addition to the several hundred dollars of free lead testing we will conduct on your home, you will be paid fifteen dollars ($15.00) for your time.

If you meet the three requirements listed above and want to have your home tested, please contact Mary at the St. Francois County Health Department at (314) 431-1947.

Appendix 8: Control Area Recruitment Advertisement

Attention Salem Parents

Free Testing for Lead in Salem Homes

With Children 6 Months to 6 Years Old

The Missouri Department of Health and Saint Louis University are conducting lead testing in Salem. Lead may be found in the dirt in your yard, paint on your home, or in the water you drink. It is especially dangerous to children. Low levels effect the way they think and act. High levels of lead exposure can cause serious injury or death.

Testing of 150 homes in Salem, Missouri has already begun. You are eligible to have your home tested for lead if:

1. You live in the city limits of Salem. (Any dwelling including mobile homes and apartments.)
2. You have lived in your home for at least 90 days.
3. You have a child in the home between 6 months and 6 years of age.

The testing takes about two hours and is done for free. It includes soil from your yard, dust in your home, paint on your house, and water in your home. It also includes a blood test for your child under the age of 6. A nurse will take a small sample from your child. There is a questionnaire that will be conducted with the parent or guardian of the child. These tests will tell you if your child is being poisoned by lead in or around your home. In addition to the free test, you will be paid fifteen dollars ($15.00) for your time.

If you meet the three requirements listed above and want to have your home tested, please contact the Dent County Health Department at (314) 729-3106.

Appendix 9: Sampling Teams

SAMPLING TEAMS

Sampling Team/Initial Date	Members/Responsibilities
1 - Primary July 19, 1995	Gary Bertram - XRF, Environmental Samples Jane Hartrup, R.N. - Blood, Interview, Environmental Samples Sharon Bach, R.N. - Blood, Interview, Environmental Samples
2 - Primary July 19, 1995	Jon Peacock - XRF, Environmental Samples Diane Eaton, R.N. - Blood, Interview, Environmental Samples Jane Howard, R.N. - Blood, Interview, Environmental Samples
3 - Primary September 20, 1995	Brad Wilson - XRF, Environmental Samples Dorothy Wilson, L.P.N.- Blood, Interview, Environmental Samples Sharon Johnson, L.P.N.- Blood, Interview, Environmental Samples
4 - Back-up July 19, 1995	Robert Royal, - XRF, Environmental Samples Barbara Huff, R.N. - Blood, Interview, Environmental Samples Judy McCarty - Interview, Environmental Samples

Appendix 10: Blood Collection Protocol

BIG RIVER MINE TAILINGS LEAD STUDY

CASE 95-0059

SPECIMEN COLLECTION AND SHIPPING PROTOCOL

Division of Environmental Health Laboratory Sciences
National Center for Environmental Health
Centers for Disease Control and Prevention
Atlanta, Georgia 30333

.evised: 07/06/95

I. INTRODUCTION

The proper collection, processing, storage and shipment of physiologic specimens from participants in this study is critical to the success of the study. The following sections describe the procedures which must be followed for all specimen collections. These procedures must be strictly adhered to in order to avoid contamination, loss, or degradation of the specimens. Please familiarize yourself with the study protocol and insure that you understand the concept of the study, the role of all the personnel involved, and your own role.

Please note that if participants are required to report to the collection site in a fasting state, blood collection should be accomplished early in the visit to avoid discomfort to the subject and an adverse impact on compliance. Blood collection must be completed and processed under carefully controlled conditions of good laboratory practice. Blood processing must be accomplished promptly to avoid degradation of the specimen.

It is extremely important that all records associated with each participant be maintained in an organized and complete manner to ensure that all information is properly collected and accurate. Specimens should be labeled promptly and processed as a unit or "run" and precautions must be taken to avoid patient-specimen-label-record mix-ups. This type of error is usually the most common error in the laboratory setting, but careful planning and a well organized work area will keep such errors at a minimum. Some of the information required for the specimen label and shipping list will be collected at the time of specimen collection. Problems in blood collection should be noted in the sample log and in the comments section of the shipping list.

II. WHOLE BLOOD COLLECTION

(UNIVERSAL PRECAUTIONS SHOULD ALWAYS BE FOLLOWED IN THE COLLECTION AND HANDLING OF HUMAN BLOOD)

A. Collection procedure

1. Materials needed per participant.

-Disposable gloves
-Gauze sponges
-Alcohol wipes (2)
-Bandaid
-3 mL purple-top vacutainer tube (1)
-23g 3/4" butterfly needle with 12" tubing with multiple sample luer adapter
-22g Vacutainer needle
-5 mL Syringes (to be used with butterfly or syringe needle for hard to get venipunctures)
-Sharps disposal container for used needles
-Pre-printed labels
-Tourniquet
-Vacutainer needle holder (pediatric size for 3 mL tubes)
-Vacutainer needle holder with pediatric tube adapter
-Refrigerator or container with ice packs

<u>NOTE: USE ONLY THE SUPPLIES PROVIDED BY CDC WHICH HAVE BEEN SCREENED FOR LEAD</u>

2. Venipuncture procedure.

-Locate a suitable table and chair for blood collection and lay out blood collection supplies.

-Locate the puncture site. Hold with 2 fingers on one side of the "alcohol wipe" so that only the other side touches the puncture site. Wipe the area in a circular motion beginning with a narrow radius and moving outward so as not to cross over the area already cleaned. Repeat with a second alcohol wipe.

-Locate vein and cleanse in manner previously described, then apply the tourniquet. If it is necessary to feel the vein again, do so; but after you feel it, cleanse with alcohol prep again, and dry with a sterile gauze square.

-Fix the vein by pressing down on the vein about 1 inch below the proposed point of entry into the skin and pull the skin taut. Approach the vein in the same direction the vein is running, holding the needle so that a 15°° angle with the examinee's arm.

-Push the needle, with bevel facing up, firmly and deliberately into the vein. Activate the vacuum collection tube. If the needle is in the vein, blood will flow freely into the tube. If no blood enters the tube, probe for the vein until entry is indicated by blood flowing into the tube.

-After blood flow is established, loosen the tourniquet. Collect ONE 3ml purple top tube per participant and after collection, invert the tubes gently to mix the blood with the contained anticoagulant. Release the tourniquet entirely after the last tube has filled. Withdraw the needle with a swift motion.

-When the needle is out of the arm, press gauze firmly over the puncture site. Heavy pressure as the needle is being withdrawn should be avoided to prevent the sharp point of the needle from cutting the vein.

-If blood cannot be collected using the vacutainer system, pre-screened syringes have been provided for sample collection. USE ONLY THE SYRINGES WHICH HAVE BEEN PROVIDED. After collecting the blood (3 mL) in the syringe transfer the blood as soon as possible to the purple-top tube. This may be accomplished by pushing the needle used to collect the blood from the subject into the stopper of the purple-top tube and allowing the vacuum in the tube to transfer the blood from the syringe. If the stopper has to be removed in order to transfer the blood, extreme care must be taken to avoid contamination of the top of the tube and the stopper. Invert the tubes immediately to mix.

-Have the examinee raise his arm (not bend it) and continue to hold the gauze in place for several minutes. This will help prevent hematomas.

-Report to the physician any reaction experienced by the participant during the venipuncture procedure.

-Place a bandaid on the subject's arm.

B. Processing procedure

-Assign an id number to each participant and the tube with the preprinted labels provided.

-Extra labels are provided for paperwork or any other document to cross reference the number assigned with the participant to whom it was assigned.

-Record each collection on the inventory/shipping list provided.

-Place tubes in the storage boxes provided. Refrigerate (DO NOT FREEZE) these tubes until they can be sent back to CDC.

-Place each box in a zip-lock back before shipping.

III. SHIPMENT OF SPECIMENS TO CDC, ATLANTA, GA.

A. BEGINNING OF STUDY AND GENERAL INSTRUCTIONS

1. Determine the times 'FEDERAL EXPRESS' packages are picked up in order to connect with the best flights to Atlanta, Georgia. Shipments to Atlanta may be scheduled weekly and scheduled on Monday through Thursday mornings. IMPORTANT: Since the materials packed in accordance with the instructions below will remain cool (over cold packs) only about 2 days, shipments should not arrive in Atlanta on weekends or on Federal holidays. If another carrier is used, inquire about their requirements when shipping blood specimens.

2. Inquire about regulations in your area concerning shipment of human blood. Whole blood shipments will require the use of cold packs to keep the materials cool during shipment (NOT FROZEN). Also, make sure the specimens will be received at CDC within 24 hours. For all shipments, do not pack shippers with the specimens and coolant until just before shipment.

3. Telephone or fax the laboratory at CDC the day the shipment is mailed Tel:(404) 488-4305, Fax:(404) 488-4192. Speak with Charles Dodson.

B. SPECIMEN SHIPPING LIST

1. For each shipment, fill out a Specimen Shipping List provided by CDC. Please give the following information on the shipping lists:

   a. Page number - e.g. 1 of 4
   b. Shipment Number-number shipments sequentially starting with 1.
   c. Total number of refrigerated shippers containing whole blood specimens which are being mailed in this shipment;
   d. Type of Specimens- whole blood, serum, or urine.
   e. Number of Specimens- number of each type of specimen shipped
   f. Name, Title, Signature, and Phone Number of person sending shipment or initials as indicated on the continuation sheets.
   g. Date shipped
   h. Specimen ID for each participant-e.g. 95-0059-0001. For each participant, check (X) each individual specimen type/aliquot included in this shipment
   i. Date Collected- e.g. MM-DD-YY
   j. Comments- Specify any deviations from collection, storage, and shipment protocols, and date of occurrence.

Make a copy of the completed shipping list. The original to be shipped with the specimens, and the copy retained for your records.

C. REFRIGERATED SPECIMENS

1. Materials needed per shipper

   -1 styrofoam shipper
   -cardboard freezer boxes capable of holding 3 mL purple-top vacutainer tubes
   -cold packs (freeze before shipping)
   -bubble packing material or similar packing marterial
   -filament tape
   -gloves for handling frozen cold packs
   -'FEDERAL EXPRESS' airbill or any overnight carrier
   -'HUMAN BLOOD-THIS SIDE UP' labels
   -'KEEP REFRIGERATED - DO NOT FREEZE' labels
   -zip-lock bag
   -refrigerated blood specimens in 3 mL purple-top vacutainer tubes

2. Packing procedure

   -Place cold packs in a -20°C freezer the day before the shipment. Four 24 ounce packs will be needed for each shipper used.

   -Working quickly, so that the blood will not be exposed to ambient temperature for more than 5-10 minutes, place 2 ice packs in the bottom of the shipper. Cover with the bubble wrap before adding the boxed specimens. Place additional bubble wrap over the boxes before adding the 2 remaining cold packs. Fill with additional bubble wrap and place the styrofoam lid on top of the shipper.

   -Secure the outer carton lid on the shipper with the filament tape.

3. Shipping procedure.

   -Cover or remove previous address labels on all shippers.

   -Label each shipper with the following:

   .'FEDERAL EXPRESS' airbill with the following address:

   Charles Dodson
   Centers for Disease Control
   National Center for Environmental Health
   4770 Buford Highway NE
   Building 17 Loading Dock
   Atlanta GA 30341-3724

   .'HUMAN BLOOD-THIS SIDE UP' label
   .'KEEP REFRIGERATED-DO NOT FREEZE' label

   -Call the 'FEDERAL EXPRESS' office at 1-800-238-5355 to arrange for pick-up.

   -On the day of shipment, call or fax Charles Dodson at the numbers given on page 6

SPECIMEN TEST NAME	ABBREVIATION
LEAD	PB

THE ABOVE TEST IS PERFORMED UTILIZING WHOLE BLOOD COLLECTED IN 3 mL PURPLE-TOP TUBES CONTAINING 4.5 MG OF EDTA(K3) AND 0.012 MG OF POTASSIUM SORBATE IN 0.06 mL OF 7.5% EDTA(K3) SOLUTION (PURIFIED WATER TO VOLUME).

A TOTAL OF 3 mL OF BLOOD IS ALL THAT IS REQUIRED FROM EACH PARTICIPANT.

BIG RIVER MINE TAILINGS LEAD STUDY

CASE 95-0059

WHOLE BLOOD COLLECTION AND PROCESSING PROTOCOL

BLOOD (3 mL FASTING)

(1) 3 mL purple-top tube
B1
"BLOOD LEAD"

Refrigerate and store
at 4°C

Ship to CDC on ice packs
using 'FEDERAL EXPRESS'
label

NOTE: ALL ITEMS IN QUOTES AND UNDERLINED ARE "LABELS"

WHOLE BLOOD COLLECTION/SHIPPING LOG

BIG RIVER MINE TAILINGS LEAD STUDY

CDC STUDY NO. 95-0059

B1 = BLOOD LEAD

For each specimen collected indicate below the participant id number, mark the spaces with an (X) to indicate that blood was collected or (O) if unable to collect.

PARTICIPANT ID NO.	B1	COLLECTION DATE	COMMENTS (SPECIFY DEVIATIONS IN COLLECTION, STORAGE, OR SHIPMENT)

SPECIMEN SHIPPING SUMMARY
BIG RIVER MINE TAILINGS LEAD STUDY
CDC STUDY NUMBER 95-0059

Shipment Number: ______________________________

Shipment Date: ______________________________

Shipped By (PRINT): ______________________________

Signature: ______________________________

Number of Shippers (Boxes): ______________________________

Received By: ______________________________

Signature ______________________________

Date Received: ______________________________

Appendix 11: Environmental Sampling Protocols and Forms

SOP 100

Environmental Sampling Protocol
Indoor Environmental Assessment Form
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of information for the "Indoor Environmental Assessment Form".

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: An "Indoor Environmental Assessment Form" and "Home Schematic Form" will be completed for each residence and will include the study child's bedroom, the main entry area room and up to two other indicated play areas. This form will contain information by room assessed concerning room type, surface and substrate type, damage type and source if present, total and damaged area, XRF measurements obtained and general comments. A different form is used for each room.

Selection of Sample Locations:

1. The "Home Schematic Form (FRM 100)" will be completed and include a floor plan diagram of all living and play areas within the residence.
2. The study child bedroom, the main entrance area and up to two additional play areas, will be determined from the parent/guardian and indicated on the home schematic. Each of these areas will have a separate "Indoor Environmental Assessment Form (FRM 110)" completed.
3. The numbering sequence will be the study child's 'bedroom' as #1, the 'play areas' as #2 through #4, and the 'main entry area' as #5.
4. Closets will only be included if there are no doors on the closet or is large enough to be considered as a walk in closet, and will be included as part of the area being assessed.
5. An enclosed porch area will be considered as a separate indoor room. Otherwise it will be considered as an outdoor area.

6. On form indicate surfaces with similar paint histories. Identify all friction surfaces, all surfaces less then three feet from floor, and all surfaces greater than three feet from floor and greater than one square foot in area.

Sampling Equipment: Sampling equipment will consist of a minimum of:

- Tape measures large and small
- "Indoor Environmental Assessment Forms" and "Home Schematic Form"
- Pen
- Portable XRF unit (this can be used following completion of all assessment forms)
- Step ladder
- Random number generator

Method of Sampling:

1. On the "Home Schematic Form (FRM 100)" indicate all living areas by floor, indicate family dwelling type, number of floors, total number of rooms and floors, and draw a rough schematic on the backside of the form for each floor. Circle the designated child bedroom, occupant main entry area, and up to two additional child play areas. Using the Global Positioning System (GPS) determine latitude and longitude from a secured position in the backyard or porch area and indicate on form. The GPS will need to stabilize for up to fifteen minutes prior to recording reading.
2. For each area/room being assessed a separate assessment form (FRM 110) is to be completed.
3. Complete the general information part of the form identifying and describing the room area. Circle or write in the information as indicated.
4. A diagram of the room should be sketched on the reverse side of the form, or use the "Home Schematic" diagram if feasible (if so indicate use on back of form). Each common history painted surface within the room should be indicated (surface number) and assessed as to surface type and substrate type. If the surface is determined to contain (0.7 mg/cm^2 or greater), then additional information of damage and source if any, height from floor to the lowest part, and total and damaged area measurement should be completed.

- For surface type use the numbered selections given, and for substrate type the underlined bold letters. Only one response for each should be entered. If the correct response is not given, indicate 'other' and write in the correct response.
- For damage type and source enter up to three responses from the underlined bold letters.
- Total square feet should be estimated/measured to the nearest foot, and be inclusive of all surfaces with similar painting history.
- Height from floor should be estimated to the nearest foot.
- Damaged square feet, if present, should be estimated/measured to the nearest foot, and be inclusive of all surfaces with similar painting history. If there is no damage a "0" should be entered.
- The numbering system should start from the main entry into the room/area, as viewed when in the room, and go in a clockwise manner. For example, if all doors or windows appear to have a common painting history, only one of the doors or windows need be indicated with the total area, damage and source inclusive of all doors or windows. The surface indicated should be the surface in which XRF measurements are performed.

5. XRF measurements are to be determined for representative similar paint history areas on the following painted surfaces:
    - All surfaces less than three feet from the floor which are greater than one square foot in combined homogenous (similar paint history) area, or are indicated as damaged.
    - All friction surfaces including;
        - Representative window stools;
        - Representative window sashes, stops, troughs and casings from only operable windows;
        - Representative doors, jams and casings;
    - Surfaces over three feet from the floor which are indicated as damaged, or greater than ten square feet in combined homogenous (similar paint history) area.
    - Any surface which shows indication of chewing. This information should be marked in the comments area.
6. XRF Measurements (Recorded on to FRM 110)
    - At start and end of the sampling day the "XRF Use and Custody (FRM 130)" form must be completed.

- Prior to each XRF measurement the clear button should be pressed.
- The XRF measurement recorded should be the indicated 'L' shell reading after the error has reached a plus or minus 0.1 mg/cm^2. Mark '>' if indicated by the spectrum reading (note this should never be greater then >5). If the spectrum reading indicates a result cannot be accurately obtained, or a reading cannot be obtained for other reasons, mark 99 as the response.
- If more than one reading is made, record all readings in same space keeping in line with XRF sample number recorded.
- If surface is visibly soiled/dusty, place a piece of plastic or paper between the instrument and surface and/or wipe surface with a non-alcohol wipe as necessary.
- The XRF calibration check (FRMs 120) should be performed prior to use at each new location/residence, the instrument is knocked, dropped or other impact, turned off for more than one hour, and at the completion of each sampling day. (See "Calibration Check" Form).
- Mark yes (Y) or no (N) for spectrum indication if lead is buried below top layer of paint or material.
- Indicate XRF sample number given on the instrument.
- Enter any comments relevant to interpretation of XRF measurements or other potential exposure observations.

7. At the end of each sample day after the final XRF calibration check the XRF data should be down loaded into a prepared data file (SOP 920). After checking that data was properly downloaded, the instrument data file can be erased for the next use.

SOP 150

Environmental Sampling Protocol
Paint Sample Collection
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of paint samples from study residences.

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: Paint samples will be collected from potential primary lead paint sources on the interior and exterior of the residence as determined from the "Indoor and Outdoor Environmental Assessment" form and XRF results. These samples will be stored and analyzed as needed for either confirmatory results of lead content or source characterization determinations. Disposable gloves will be worn for the collection of each sample.

Selection of Sample Locations: Interior paint chip samples will only be obtained from each surface with different painting histories in the study child's bedroom and main play area(s) **indicated as having damage** which may result in release of paint **and** which are indicated as having lead content equal or greater than 0.7 mg/cm^2 by XRF analysis. **Or** for which a valid XRF reading cannot be obtained **and** where the square foot area is greater than 10 **and** the material is indicated as damaged..

One exterior paint chip sample will be collected from each painted surface which appears to have a different painting history which are **indicated as having damage** which may result in release of paint **and** which are indicated as having lead content equal or greater than 0.7 mg/cm^2 by XRF analysis. **Or** for which a valid XRF reading cannot be obtained **and** where the square foot area is greater than 100 **and** the material is indicated as damaged.

In all cases paint chip samples will only be removed from previously damaged areas which are as representative as can reasonably be achieved.

Sampling Equipment: Sampling equipment will consist of a minimum of:

- Disposable gloves.
- Razor or utility knife
- Chiseled edge scraper
- Wet wipes for decontamination
- 4-mil re-sealable bag for sample storage
- Step ladder

Method of Sampling: Samples will be collected as a sample of convenience. No damage to painted surfaces will be made. Since paint samples will only be obtained from damaged surfaces, the sample will be collected at a site of damage which is representable of the paint. If no damaged sites are available no samples will be obtained and this will be recorded.

1. Label sample container with residence ID sticker and sample number (sample number will increase sequentially starting with **P-1**)
2. Place on new pair of disposable gloves.
3. Obtain an approximate 2 inch square sample from a representable damaged area.
4. Complete sample location information on "Paint Chip Sample Collection (FRM 150)" form.
    - Indicate if sample came from (I) indoor, (O) outdoor, or (D) detached surface.
    - If indoor, give room number. If outdoor indicate wall letter.
    - Indicate surface number assigned on "Indoor or Outdoor Environmental Assessment" form.
    - Describe sample location if not clearly indicated on schematic Environmental Assessment form drawing. Include any relevant comments to interpretation of data.
    - If no damaged areas exist, indicate on the proper Environmental Assessment form in the Comments section that paint chip sample could not be obtained.
5. Place all collected samples into a large zip-lock storage freezer bag and label with residence ID number.

6. Decontaminate tools used.

SOP 200

Environmental Sampling Protocol
Dust Floor Vacuum Collection
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of dust floor vacuum samples from residences.

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: Up to five indoor composite dust vacuum samples will be collected from the study child's bedroom and play area(s) on to a 0.8 um poly cellulose acetate filter using a personal sampling pump with a nozzle attachment. Disposable gloves will be worn for the collection of each sample. All sample pumps should be charged daily and fully discharged and recharged once per week.

Selection of Sample Locations:

1. The bedroom and main play area(s) of the study child, and main entry way location (this will be the entrance most used by the occupants) will be determined from the parent/guardian being interviewed. See "Home Schematic" FRM 100..
2. The bedroom, up to three additional play areas and the main entry area will be sampled.
3. If there are greater than three play areas, then carpeted play areas will first be sampled followed by a random selection of non-carpeted areas, up to a total of three play areas. If all areas are carpeted, then a random selection of three play areas will be sampled.
4. If the area is carpeted, a vacuum sample will be taken from the center area.
5. If the area is not carpeted, a vacuum sample will be taken from the wall corner to the right of the main entry into the room (as viewed when in the room facing the entry).

Sampling Equipment: Sampling equipment will consist of a minimum of:

- Disposable gloves
- Calibrated sampling pump
- Pre-weighed or matched weight 0.8 um MCE filter in 37 mm sampling cassette.
- Vacuum nozzle attachment
- tygon tubing
- 4-mil resealable plastic bags
- Small tape measure or template
- Wet-wipe for decontamination
- Random number generator

Method of Sampling:

1. Label sample cassette and storage container with sample number (should be **V-1** for each residence).
2. Calibrate sampling pump to 2.5 L/m air flow or check with rotometer (may be calibrated at the beginning of the day and checked at the end of the day with a primary calibration standard - SOP 210 and FRM 210). Indicate that a rotometer air flow check was performed each use on the sample form. If the rotometer is off by more than one-half of a division, correct the air flow and indicate **N** under calibration check, otherwise **Y**. If the air flow needed to be corrected, recalibrate pump as soon as reasonably possible with a primary calibration standard.
3. Place on new pair of disposable gloves.
4. Measure one square foot (25 cm^2) area or use decontaminated template.
5. Hold nozzle at 45° angle from the floor and sweep in the same direction at a rate of 2 seconds per stroke, overlapping each stroke only slightly, until the entire area has been covered. Repeat the process at 90° from the initial direction.
6. Complete "Floor Dust Vacuum Collection (FRM 200)" form.
   - Dimensions of wiped area (possibilities exist where a square foot area may not be available).
   - Calibration check of pump was performed and satisfactory (Y), or needed to be corrected (N).
   - Visible soil or dust on general inspection from one foot distance.
   - Surface very smooth (1) means no irregularities during vacuum (such as very smooth hard surface floor), to very rough (5) means many irregularities (such as thick shag carpet).

7. Continue the process at each sample site until all samples have been collected on to the same filter cassette.
8. Place filter cassette into storage container.
9. Decontaminate or dispose of sampling nozzle. Decontaminate template if used with wet-wipe.

SOP 210

Environmental Sampling Protocol
Sampling Pump Calibration
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the calibration and calibration checks of sampling pumps used for dust vacuum samples.

Application: The procedure outlined in this SOP are applicable to all environmental sampling for the Big River Study.

General Guidelines: At the beginning of each sampling day the sampling pumps to be used for dust floor vacuum collection samples will be calibrated with a primary standard to 2.5 L/minute. The rotometer setting will be recorded and checked during the sample day as a qualitative measure. At the end of each sampling day the sampling pump is then checked against the primary standard to determine the end of day flow rate. Also, between each sampling day all pumps are to be charged. Once per week the pump batteries are to be depleted and recharged to avoid creation of a battery memory.

Equipment:

- Sampling pumps
- Filter and cassette same as to be used in field collection
- Tygon tubing
- Primary calibration standard (Dry-calc calibrator)

Methodology:

1. Attach sampling pump to primary calibration standard with filter and cassette in line between the two.
2. Start sampling pump and adjust flow to 2.5 L plus or minus 0.1 L.
3. After sampling pump has been adjusted perform a minimum of three, and preferably ten flow rate checks and record the average and number

of tests perfomed. Also record the pump rotometer setting to the nearest half reading.

4. Complete enter date, name of individual perfoming calibration, sampling pump SN and time on the Calibration Form (FRM 210).
5. At the end of the calibration day check the calibration:
   - Connecting the sampling pump to the primary standard with a filter and cassette between the two.
   - Perform a minimum of three, and preferably ten flow rate checks and record the average and number of tests perfomed.
   - Record the results, time and name of individual performing the calibration on the same form (FRM 210).
6. Connect the sampling pump to the charger at the end of each sampling day.
7. Once per week set the charger on drain and trickle charge.

SOP 250

Environmental Sampling Protocol
Window Stool Dust Wipe Sampling
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of interior dust wipe samples from residences.

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: Wipe sample site selection and collection will be performed after the "Indoor Environmental Assessment (FRM 110)" form has been completed. Up to five wipe samples will be obtained from selected operable window stools to form one composite sample for analysis. The areas to be sampled will be the study child's bedroom and main play area(s). All surface areas sampled will be measured. Disposable gloves will be worn for the collection of each sample.

Selection of Sample Locations:

1. The study child bedroom and main play area(s) will be determined from the parent/guardian being interviewed. See Home Schematic form (FRM 100).
2. The number of operable windows in each room will be determined by trial or information from the parent/guardian being interviewed.
3. If the number of operable windows is five or less, all windows are selected for sampling.
4. If the number of operable windows is greater than five then random sampling for one window stool in each room of the operable windows will be performed. If there are fewer than five rooms, the remaining operable windows will be randomly sampled until a total of five windows are sampled

Sampling Equipment: Sampling equipment will consist of a minimum of:

- Disposable gloves
- Wash'n Dry Wipes or similar approved product

- Measuring tape
- 4-mil re-sealable plastic containers.
- Random number generator.

Method of Sampling:

1. Complete "Wipe Sampling (FRM 250)" form header information (Residence ID sticker Composite sample number, Date, Inspector initials and general description of composite samples).
2. Label sample collection bag with composite sample number (this should be **W-1** for each residence).
3. Prior to the collection of each sample for the composite complete the following information on the sample form:
    - the room number and surface number of the sample site from the "Indoor Environmental Assessment" form.
    - Dimensions of the area to be wiped to the closest inch. This should be a rectangular area adjacent to the window sash, and not to include edges along the side of the vertical window casing.
    - Soiling Index questions.
        - If visible loose soil/dust is visible on a general inspection within one foot of the window stool, then yes, otherwise no.
        - If visible movement is observed when a light puff of air is blown on the window stool within one foot, then yes, otherwise no.
        - After each of the three wipes look at the wipe sample for visible soil/dust collection.
    - Smoothness of surface. This recorded after sampling. A very smooth (1) surface would have no grooves felt or catching edges during the wipe sample. A very rough (5) surface would contain numerous ridges and/or catching edges during the wipe sample.
    - General comments concerning conditions or sampling procedure which may affect interpretation of results.
4. Place on new pair of disposable gloves
5. If the wipe sample media used comes from a continuous roll, such as Wash'n Dry, then the first towelet should be removed and disposed of. If this is the first wipe removed during the day, the first two towelets should be disposed.
6. Remove a new towelet and place flat at one end of the window sill and wipe in an 'S' pattern over the entire surface making sure that each

stroke only slightly overlaps the previous stroke. Fold the wipe in half with the dirt side inside, and the re-wipe the sill at 90° from the first wipe. Fold the wipe again in the same manner and re-wipe the stool similar to the first wipe. Again fold the dirt side inside and place into the pre-labeled sample container.

SOP 300

Environmental Sampling Protocol

Vacuum Bag Collection

Standard Operating Procedure

for

Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of vacuum bag samples from residences.

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: Contents of the vacuum cleaner will be collected by placing disposable vacuum cleaner bags, or emptying non-disposable bags into the collection container. Disposable gloves will be worn for the collection of each sample.

Selection of Sample Locations:

1. The resident will be requested to identify and open (or give permission to open) the household vacuum cleaner. If there is more than one vacuum cleaner the one indicated as being used primarily for the bedroom and play area(s) of the study child will be used.
2. If resident will not allow disposable bag to be removed, and contents cannot be emptied, then no samples will be obtained and so indicated on the collection form.

Sampling Equipment: Sampling equipment will consist of a minimum of:

- Disposable gloves
- 4-mil plastic re-sealable bags (12" x 15"). Small garbage bags of at least 0.6 mil with twist ties may be used for disposable bag samples.

Method of Sampling:

1. Label sample container with sample residence ID sticker and number. Sample number should be **B-1** for each residence.
2. Place on new pair of disposable gloves.
3. If vacuum bag is disposable type, place entire bag into sample collection container.

4. If vacuum bag is non-disposable empty contents of vacuum cleaner into sample collection container.
5. Seal sample collection container.
6. Complete "Vacuum Cleaner Bag Collection (FRM 300)" form.

SOP 350

Environmental Sampling Protocol
Drinking Water Sample Collection
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of drinking water samples from residences.

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: First draw kitchen cold tap drinking water samples will be collected into sample containers with nitric acid preservative supplied by the laboratory performing the analysis. Disposable gloves will be worn for the collection of each sample.

Selection of Sample Locations: The drinking water sample will be collected from the cold tap of the kitchen faucet.

Sampling Equipment: Sampling equipment will consist of a minimum of:
- Disposable gloves.
- 250 or 1000 ml polyethylene bottles containing nitric acid stabilizer supplied by the laboratory performing the analysis.

Method of Sampling:

1. When the site visit is being arranged the resident will be requested not to use the kitchen water tap for eight hours prior to site visit.
2. Label sample collection container with sample number (should be **W-1** for each location).
3. Place on new pair of disposable gloves.
4. Place collection container under cold water kitchen faucet.
5. Fill container.
6. Seal sample collection container.
7. Complete "Drinking Water Collection (FRM 350)" form.
    - Sample location and date identifiers (number, date and inspector)

- Collection time in 24 hour system.
- Determine from occupant the amount of elapsed time since last used to closest half-hour.
- Circle closest approximation of collection volume.
- Indicate if collection was made in site different from the kitchen.

SOP 400

Environmental Sampling Protocol
Outdoor Environmental Assessment Form
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of information for the "Outdoor Environmental Assessment Form".

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: An "Outdoor Environmental Assessment Form (FRM 400" will be completed for each residence and will include all exterior painted areas. This form will contain information by exterior wall or detached areas, assessing surface and substrate type, damage type and source if present, total and damaged area, XRF measurements obtained and general comments. A different form is used for each wall with a reasonably assumed similar painting history. All detached areas are put onto one form.

Selection of Sample Locations:

1. All outdoor representative homogenous (surfaces with similar painting histories) surfaces whether attached or detached from the residence and which are greater than ten square-feet in surface area, any damaged surface bordering a non-vegetated soil or hard surface play area and representable window sashes, casings, stops and wells, doors, jams and casings, will be included on the "Outdoor Environmental Assessment Form". If any painted play equipment, fences our structures within the yard are present they should be identified on the detached form.
2. The Wall numbering sequence which identifies the distinct side of the residence will start at the street address main entrance side to the residence as 'A', and will increase alphabetically in a clockwise direction.

Sampling Equipment: Sampling equipment will consist of a minimum of:

- Tape measures large and small

- "Outdoor Environmental Assessment Forms (FRM 400)"
- Clip board
- Pen
- Portable XRF unit (this can be used following completion of all assessment forms)
- Step ladder
- Random number generator

Method of Sampling:

1. A separate form will be completed for each distinct Wall area which is reasonably assumed to have a similar painting history (typically side of residence) and for detached surface areas (play area equipment, fences and other detached painted surfaces) being assessed. Draw an aerial schematic of the yard on the first form used, indicating the designated Wall letter **and insure that all detached surfaces are indicated** (the "Away From House Soil Collection" form can be used if feasible, but indicate such use on the back of the form). Each form used should have a side-view schematic numbering the surfaces as is reasonable in the diagram.
2. Complete the general information part of the form identifying and describing the area.
3. Each painted surface should be indicated (surface number) and assessed as to surface type and substrate type. If, after XRF analysis the surface is found to contain lead at 0.7 mg/cm^2 or greater, then information on damage and source if any, and total and damaged area measurement should be completed.
    - For surface type use the numbered selections given, and for substrate type the underlined bold letters. Only one response for each should be entered. Of the correct response is not given, indicate 'other' and write in the correct response.
    - For damage type and source enter up to three responses from the underlined bold letters.
    - Total square feet should be estimated/measured to the nearest foot, and be inclusive of all surfaces with similar painting history.
    - Damaged square feet, if present, should be estimated/measured to the nearest foot, and be inclusive of all surfaces with similar painting history. If there is no damage a "0" should be entered.

4. XRF measurements will be determined on all painted surfaces greater than ten square-feet in surface area, and any damaged surface bordering a non-vegetated soil or hard surface play area. Only the ground level floor and items which can be reached with a small step ladder will be tested.
    - At start and end of the sampling day the "XRF Use and Custody (FRM 130)" form must be completed.
    - Prior to each XRF measurement the clear button should be pressed.
    - The XRF measurement record should be the indicated 'L' shell reading after the error has reached a plus or minus 0.1 mg/cm^2. Mark '>' if indicated by the spectrum reading (note this should never be greater then >5). If the spectrum reading indicates a result cannot be accurately obtained, or a reading cannot be obtained for other reasons, mark 99 as the response.
    - If more than one reading is made, record all readings in same space keeping in line with XRF sample number recorded.
        - If surface is visibly soiled/dusty, place a piece of plastic or paper between the instrument and surface. Wipe surface with a non-alcohol wipe as necessary.
        - The XRF calibration check should be performed prior to use at each new location, the instrument is knocked, dropped or other impact, or turned off for more than one hour. (See "Calibration Check" Form FRM 120).
        - At the end of each sample day the XRF data should be down loaded into a prepared data file. After checking that data was properly downloaded, the instrument data file can be erased for the next use. (SOP 920).
    - Mark yes (Y) or no (N) for spectrum indication if lead is buried below top layer of paint or material.
    - Indicate XRF sample number given on the instrument.
    - Enter any comments relevant to interpretation of XRF measurements or other potential exposure observations.
5. For play area equipment and other detached painted surfaces, in the comments section indicate the Wall letter which is opposite the surface type. Draw separate schematics as may be needed.

SOP 450

Environmental Sampling Protocol
House Drip Line Soil Collection
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of soil samples within the drip line of each study residence.

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: A composite of up to five soil samples one-half inch each of normal top soil without vegetation will be collected from the drip line area of the house (i.e. Within three feet of the exterior wall). Disposable gloves will be worn for the collection of each sample.

Selection of Sample Locations:

1. An aerial view diagram of the residence will be sketched, or the "Away From House (SOP 500 and FRM 450)" soil sample sketch can be used. The four main sides of the residence will delineate a sample area and should border and should be contiguous with the "Away From House" soil sample collection areas. Where there is a distinct difference in the house exterior structure a fifth side/sample will be added. Wherever possible the natural outlines of the residence and yard will be used to segregate the sample areas. The main street entrance region will be numbered as '1' with increasing count in a clockwise direction.
2. Within each of the areas (up to five), non-vegetated regions which are not child play areas will be indicated which are between six inches and two and one-half feet from the house wall. If there is more than one non-vegetated non-play area, one will be randomly selected for sampling. Samples will be collected from the center of each sample area, but at least three feet from any rain spout or outer water run-off.
3. If there are no non-vegetated non-play areas, a sample site will be selected at the approximate mid-point of the region. The vegetated material will be removed from the sample prior to addition to the composite sample collection container.

4. If a designated region does not contain any soil within the designated region of the structure, then no sample will be taken from this region. If fewer than four regions have soil areas for sampling, then additional soil samples will be taken from the largest existing region in a random selection site as described above. If four samples have still not been collected, then the next largest region will be selected, and so on.

Sampling Equipment: Sampling equipment will consist of a minimum of:

- Disposable gloves
- Slotted 7/8 inch soil recovery probe
- Wet wipes and paper towels for decontamination
- Bucket of water and brush for decontamination
- 4-mil resealable plastic bags (8"x 8")
- Large zip-lock freezer bags
- Large tape measure
- Knife

Method of Sampling:

1. Label sample storage container with composite sample number.
2. Complete "Soil Collection (FRM 450)" form for composite sample to be obtained. This will entail: determining the percent of bare ground to covered ground in sectioned area. Covered ground is considered vegetation (as described below) and hard surfaces (concrete, asphalt, etc.); and, testing the soil consistency in a location adjacent to where the sample is to be collected:
    - Soil compaction is determined by pressing on the intact soil. If the soil will not compress, or give, to the pressure it is compact (1). If the soil easily compresses and if spaces by seen between soil particles it is loose (5).
    - If soil breaks-up or crumples easily with finger pressure into small particles it is easily broken (1). If soil must be pried apart or impact force used to break-up is is difficult (5).
    - Soil which is wet enough to thickly 'pour' out of the hand is considered wet (1) to soil with no obvious moisture as dry (5).
    - A soil surface area which is totally covered with grass or other live organic material with a root system is vegetated (1). A totally bare soil surface area is non-vegetated (5).

3. The direction of the sectioned area facing away from the residence and that wall letter designation should be recorded for each sample in the composite.
4. Place on new pair of disposable gloves.
5. Remove any visible paint chips and other non-soil debri prior to taking sample and indicate presence of paint chips on sample site form in description section for sample area.
6. Insert soil probe at least two inches into soil and remove with sample.
7. Remove any vegetation from top of soil sample.
8. Cut out top half-inch of sample and slide into collection container.
9. Dispose of any remaining soil and wipe residual soil from sample probe.
10. Continue the process at each sample site placing each new composite into sample container until at least four samples have been collected.
11. De-contaminate sample probe (and knife if not disposable) by wiping off all visible soil with gloved hand and paper towels/wipes. Place soil probe into bucket and brush inside and outside of probe. Change water as appropriate.

SOP 500

Environmental Sampling Protocol
Away From House Soil Collection
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of away from house soil samples from study residences.

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study. Within the study area a side-by-side soil sample of six-inch depth will be obtained in a similar fashion.

General Guidelines: Away from house composite yard soil samples of up to five one-half inch each of normal top soil without vegetation will be collected. Disposable gloves will be worn for the collection of each sample.

Selection of Sample Locations:

1. An aerial view diagram of the residence and property will be sketched, on the reverse side of the "Soil Collection (FRM 450) Form", and divided visually into four approximate equivalent yard areas extending from the corner of the residence to the nearest corner of the property boundary. Wherever possible the natural outlines of the residence and yard will be used to segregate the areas, and the exterior wall letter designations will be indicated on the sketch. A fifth area will be used depending on the property and residence configuration.
2. The sample areas will be identified with the main street entrance area as '1' and increasing count in a clockwise direction. This should correspond with the exterior wall letter designations as much as possible.
3. Within each of the selected areas, non-vegetated regions which are not child play areas will be indicated which are greater than three and one-half feet from the house wall. If there is more than one non-vegetated non-play area, one will be randomly selected for sampling. Samples will be collected from the center of each sample area and at least three feet from any water run-off source.

4. If there are no non-vegetated non-play areas, a sample site will be selected at the approximate mid-point of the region. The vegetated material will be removed from the sample prior to addition to the composite sample collection container.
5. If a designated region does not contain any soil outside of three and one-half feet of the structure, then no sample will be taken from this region. If fewer than four regions have soil areas for sampling, then additional soil samples will be taken from the largest existing region in a random selection site as described above. If four samples have still not been collected, then the next largest region will be selected, and so on.

Sampling Equipment: Sampling equipment will consist of a minimum of:
- Disposable gloves
- Slotted 7/8 inch soil recovery probe
- Wet wipes and paper towels for decontamination
- Bucket of water and brush for decontamination
- 4-mil resealable plastic bags (8"x 8" for 1/2" cores, 12"x 15" for 6" cores)
- Extra large (for six-inch cores) and large (for one-half-inch cores) zip-lock freezer bags
- Large and small tape measure
- Knife
- Random number generator

Method of Sampling:
1. Label sample storage container with residence ID sticker and composite sample number. Sample number should be a sequential number for all soil samples starting with **S-?**.
2. Complete "Soil Collection (FRM 450)" form for composite sample to be obtained. This will entail checking sample type at top of form and determining the percent of bare ground to covered ground in sectioned area. Covered ground is considered vegetation (as described below) and hard surfaces (concrete, asphalt, etc.), and testing the soil consistency in a location adjacent to where the sample is to be collected:
    - Soil compaction is determined by pressing on the intact soil. If the soil will not compress, or give, to the pressure it is compact (1). If the soil easily compresses and if spaces by seen between soil particles it is loose (5).

- If soil breaks-up or crumples easily with finger pressure into small particles it is easily broken (1). If soil must be pried apart or impact force used to break-up is difficult (5).
- Soil which is wet enough to thickly 'pour' out of the hand is considered wet (1) to soil with no obvious moisture as dry (5).
- A soil surface area which is totally covered with grass or other live organic material with a root system is vegetated (1). A totally bare soil surface area is non-vegetated (5).

3. The direction of the sectioned area facing away from the residence, the distance to the closest perpendicular wall, and that walls letter designation should be recorded for each sample in the composite.
4. Place on new pair of disposable gloves.
5. Insert soil probe at least two inches for one-half inch samples, and eight inches for six inch soil samples, into soil and remove with sample.
   - When samples are collected within the 'study area' (not the control area), wherever a half-inch sample is collected for a soil composite a six-inch sample will also be obtained within six-inches of the half-inch core site. A separate composite sample will be collected for the six-inch cores.
6. Remove any vegetation from top of soil sample.
7. Cut out top half-inch, or six inches of sample, as appropriate, and slide or place into collection container.
8. Dispose of any remaining soil and wipe residual soil from sample probe.
9. Continue the process at each sample site placing each new composite into sample container until at all samples have been collected.
10. Place sample collection container into extra large zip-lock freezer storage bag for six-inch samples, and a large zip-lock freezer bag for half-inch samples.
11. De-contaminate sample probe (and knife if not disposable) by wiping off all visible soil with gloved hand and paper towels/wipes. Place soil probe into bucket and brush inside and outside of probe. Change water as appropriate.

SOP 550

Environmental Sampling Protocol
Home Play Area Soil Collection
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of soil samples within child play areas of each residence.

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: A composite of soil samples one-half inch each of normal top soil without vegetation will be collected from the indicated child play areas of the house. Disposable gloves will be worn for the collection of each sample.

Selection of Sample Locations:

1. The aerial view diagram of the residence sketched and areas indicated for the "Away From House Soil Collection (FRM 450) Form" may be used, or a new sketch made. The study child play areas will be marked as indicated by the parent/guardian being interviewed. Sand boxes and other non-soil areas will not be included.
2. Each of the non-vegetated play areas indicated (up to five) will be sampled. If there are more than five play area sites that are non-vegetated up to a total of five will be randomly selected. If there are less than four, a random sample among all sites will be performed until there are a minimum of four samples collected.
3. Samples will be collected from the center of each sample area.

Sampling Equipment: Sampling equipment will consist of a minimum of:

- Disposable gloves
- Slotted 7/8 inch soil recovery probe
- Wet wipes and paper towels for decontamination
- Bucket of water and brush for decontamination
- 4-mil resealable plastic bags (8"x 8" for 1/2" cores, 12"x 15" for 6" cores)

- Extra large zip-lock freezer bags
- Large tape measure
- Knife

Method of Sampling:

1. Label sample storage container with composite sample number.
2. Complete "Soil Collection (FRM 450)" form for composite sample to be obtained. This will entail determining: determining the percent of bare ground to covered ground in sectioned area. Covered ground is considered vegetation (as described below) and hard surfaces (concrete, asphalt, etc.); and, testing the soil consistency in a location adjacent to where the sample is to be collected:
    - Soil compaction is determined by pressing on the intact soil. If the soil will not compress, or give, to the pressure it is compact (1). If the soil easily compresses and if spaces by seen between soil particles it is loose (5).
    - If soil breaks-up or crumples easily with finger pressure into small particles it is easily broken (1). If soil must be pried apart or impact force used to break-up is difficult (5).
    - Soil which is wet enough to thickly 'pour' out of the hand is considered wet (1) to soil with no obvious moisture as dry (5).
    - A soil surface area which is totally covered with grass or other live organic material with a root system is vegetated (1). A totally bare soil surface area is non-vegetated (5).
3. The direction of the sectioned area facing away from the residence, the distance to the closest perpendicular wall, and that walls letter designation should be recorded for each sample in the composite.
4. Place on new pair of disposable gloves.
5. Insert soil probe at least two inches into soil and remove with sample.
6. Remove any vegetation from top of soil sample.
7. Cut out top half-inch of sample and slide into collection container.
8. Dispose of any remaining soil and wipe residual soil from sample probe.
9. Continue the process at each sample site placing each new composite into sample container until at least four samples have been collected.
10. Place sample collection container into large zip-lock freezer storage bag.
11. De-contaminate sample probe (and knife if not disposable) by wiping off all visible soil with gloved hand and paper towels/wipes. Place soil probe

into bucket and brush inside and outside of probe. Change water as appropriate.

SOP 600

Environmental Sampling Protocol
Community Play Area Soil Collection
Standard Operating Procedure
for
Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection of soil samples from community/neighborhood child play areas.

Application: The procedure outlined in this SOP are applicable to all personnel collecting environmental samples for the Big River Study.

General Guidelines: A composite of up to five soil samples one-half inch each of normal top soil without vegetation will be collected from each indicated community/neighborhood child play area. Disposable gloves will be worn for the collection of each sample.

Selection of Sample Locations:

1. Study children common community play areas will be determined from the parent/guardian interview information.
2. For each community play area an aerial view diagram of the play area will be sketched. All non-vegetated play areas greater than ten square feet will be indicated. Sand boxes and other non-soil areas will not be included. If there are fewer than four non-vegetated play areas, then the vegetated play areas will be indicated.
3. Up to five non-vegetated areas will be randomly selected. If there are fewer than five areas, then a random selection among the vegetated areas will be made until there are five sample areas. The sample areas will be identified with the north most area as '1' and increasing count in a clockwise direction.
4. Samples will be collected from the center of each selected sample area.

Sampling Equipment: Sampling equipment will consist of a minimum of:

- Disposable gloves
- Slotted 7/8 inch soil recovery probe
- Wet wipes and paper towels for decontamination

- Bucket of water and brush for decontamination
- 4-mil resealable plastic bags (8"x 8" for 1/2" cores, 12"x 15" for 6" cores)
- Large zip-lock freezer bags
- Large tape measure
- Knife
- Random number generator

Method of Sampling:

1. Label sample storage container with composite sample number.
2. Complete "Soil Collection (FRM 450)" form for composite sample to be obtained. This will entail determining the percent of bare ground to covered ground in sectioned area. Covered ground is considered vegetation (as described below) and hard surfaces (concrete, asphalt, etc.), and, testing the soil consistency in a location adjacent to where the sample is to be collected:
    - Soil compaction is determined by pressing on the intact soil. If the soil will not compress, or give, to the pressure it is compact (1). If the soil easily compresses and if spaces by seen between soil particles it is loose (5).
    - If soil breaks-up or crumples easily with finger pressure into small particles it is easily broken (1). If soil must be pried apart or impact force used to break-up is difficult (5).
    - Soil which is wet enough to thickly 'pour' out of the hand is considered wet (1) to soil with no obvious moisture as dry (5).
    - A soil surface area which is totally covered with grass or other live organic material with a root system is vegetated (1). A totally bare soil surface area is non-vegetated (5).
3. Place on new pair of disposable gloves.
4. Insert soil probe at least two inches into soil and remove with sample.
5. Remove any vegetation from top of soil sample.
6. Cut out top half-inch of sample and slide into collection container.
7. Dispose of any remaining soil and wipe residual soil from sample probe.
8. Continue the process at each sample site placing each new composite into sample container until at all samples have been collected.
9. Place sample collection container into a large zip-lock freezer storage bag.

10. De-contaminate sample probe (and knife if not disposable) by wiping off all visible soil with gloved hand and paper towels/wipes. Place soil probe into bucket and brush inside and outside of probe. Change water as appropriate.

SOP 900

Environmental Sampling Protocol

Field QA/QC Samples

Standard Operating Procedure

for

Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for the collection and submittal of laboratory spike samples as an assessment of laboratory quality control, laboratory blanks to assess media component contamination, field blank samples to assess field methodology contamination, and field second collection samples to assess variability in the media sampled.

Application: The procedure outlined in this SOP are applicable to all environmental sampling for the Big River Study.

General Guidelines: All laboratories involved in the sample analysis will be: accredited through the American Industrial Hygiene Association Laboratory Accreditation Program for metal analysis; and, be a participant in the Lead Proficiency and Analytical Testing (LPAT) program with satisfactory proficiency ratings; and, be accredited for drinking water analysis within a State.

As one of the components to assess laboratory analysis quality control the following will be performed:

- Spiked vacuum filter (20%), wipe (2%), soil (2.5%) and water (2.5%) samples prepared by a third party laboratory using NIST standards will be submitted with normal field samples.
- Split soil (5%) and water (5%) samples will be submitted to a second laboratory for sample preparation and analysis concentration verification.
- Media blanks for each lot used of filters, sample storage containers, and gloves, for laboratory use will be maintained and analyzed for interference by the laboratory.

To assess possible contamination from presence in the field the following will be performed:

- One field blank per sampling day per sampling team will be submitted for laboratory analysis of vacuum filters and wipes.
- One field blank per every 40th residence per sampling team will be submitted for laboratory analysis of wipe media and wipe samples of latex gloves.

To assess variability of the analytes within the soil sample media a second sample will be taken for 5% of the soil samples within six inches of the first sample.

Spiked Laboratory Samples: Dust spiked samples shall be submitted as part of the regular sample submittals by the Field Project Manager in a manner so that the laboratory cannot distinguish the spiked samples from the field samples. Spiked wipe samples will be submitted for every 50 field wipe samples. Spiked vacuum filters will be submitted for every 5 field vacuum samples. Spiked soil samples will be submitted for every 40 field soil samples. Spiked water samples will be submitted for every 40 field collected water samples.

The spiked samples will be given the sample number and ID of the location of the last home performed on the sample day each spike is submitted. On the appropriate sample form the word "Spike" will be entered.

The following NIST Standard Reference Materials (SRM's) will be used for the spikes:

- Wipe samples - NIST Lead Paint Dust Standard Powdered Lead Based Paint SRM 1579a.
- Filter samples - NIST Standard Urban Particulate Standard SRM 1648.
- Water samples - NIST traceable solutions for lead by graphite furnace absorption.
- Soil samples - NIST Standard Montana II Soil SRM 2711.

Split Samples: Split samples of soil will be obtained for 5% of the samples and submitted to a second laboratory for analysis verification..

Water samples will be split in the field by taking a 500 ml sample and using this sample to fill two 250 ml containers supplied by the laboratory. One of these samples will be sent to the secondary laboratory.

From each set of 20 sequential soil prepared by the laboratory a random sample will be selected and sent to the second laboratory.

Split samples will be given a separate sample number to distinguish between the two with the word "Split Sample" entered in the comments section of the appropriate form.

Laboratory Media Blanks: Laboratory media blanks for filters, wipes, gloves and sample storage containers will be maintained or sent to the laboratory for each lot number.

- Filters will be supplied by the laboratory.
- Water containers will be supplied by the laboratory.
- Gloves will be supplied by the contractor.
- Other sample storage containers will be supplied by the contractor (4-mil and 8-mil zip-lock bags).

Field Blanks: Field sampling media blanks for filters and wipes will be supplied to the laboratory at a rate of one per sampling day per sampling team. Field blanks for gloves and sample bag containers will be submitted at a rate of 1 per 40 sampling sites per sampling team. These will be submitted with the field samples collected each week. The field sample blanks will be collected during the sampling at the final sample site of the day.

Filter field blanks will be obtained by removing the end-plugs on a filter cassette, then re-inserting the end-plugs and placing into a similar labeled sample container as the field samples. A sample collection form (FRM 200) is completed with the words "Field Blank" written in the comments section.

Wipe field blanks will be obtained by first removing and disposing of the top wipe, and then removing three wipes and placing into a similar labeled sample container as the field samples. A sample collection form (FRM 250) is completed with the words "Field Blank" written in the comments section.

Glove field blanks will be obtained by removing two gloves as would normally be performed and placing on the hands. Three successive wipes, after throwing away the first wipe, will be made of the gloves and the wipes submitted as field blanks for the gloves in a sample container. The words "Glove Field Blank" and the ID number are written on the sample container and the chain of custody form.

Sample bag field blanks will be obtained by removing a sample bag, one of each size as would normally be performed and placing into a sample container. The words "Sample Bag (bag type) Field Blank" and the ID number are written on the sample container and the chain of custody form.

If two field sample blank results in a row are greater than detectable but below the quantitative limit, the field sampling methodology will be reviewed and observed to determine contaminant sources or mechanisms. If and field sample blank result is greater than the quantitative limit, the field sampling methodology will be reviewed and observed to determine contaminant sources or mechanisms.

Second Samples: A second one and one-half inch soil sample will be collected within six inches of each soil sample for every twenty samples taken to form a second composite. The soil collection form (FRM 450) will be completed and the words "Second Sample" will be written in the comments section . A sequential sample number will be given (S-2).

SOP 910

Environmental Sampling Protocol

Sample Chain of Custody, Storage and Transport

Standard Operating Procedure

for

Big River Study

Purpose: The purpose of this SOP is to establish uniform procedures for completion and compliance with the chain of custody requirements, storage requirements and transport of samples to the laboratory or secondary storage location.

Application: The procedure outlined in this SOP are applicable to all environmental sampling for the Big River Study.

General Guidelines: At the end of each sample day "Chain of Custody Record (FRM 910)" forms will be completed for each residence sampled that day. The samples are stored at the designated storage location and conditions each day. Once per week the samples are transported by the field project manager, or designated individual, to Saint Louis University or the selected laboratory.

Equipment:

- Refrigerator or coolers and ice packs for water samples which are not stabilized with nitric acid.
- Storage containers (rigid cardboard boxes or similar container) for soils, filters, wipes, paint chips and vacuum bags.

Methodology:

1. At the end of each sampling day all collected environmental samples from each residence will be entered onto a "Chain of Custody Record" form (FRM 910).
2. At the end of each sampling day all samples will be stored in secured locations. The water samples will be stored in a designated refrigerator or cooler with ice packs if not stabilized with nitric acid. All other samples will be stored in a solid storage container such as a rigid cardboard box with a lid, or other similar container.

3. Once per week all samples will be transported to Saint Louis University or the Laboratory by the Field Project Manager or designated individual.
4. Whenever the samples change hands, such as from environmental technicians to individual transporting samples to the laboratory accepting the samples, the chain of custody record will remain with the samples and be completed (signed and dated) by all associated individuals.
5. A copy of the Chain of Custody form when it is first completed each day, and a second copy with the final transfer signature from the laboratories will be made and kept on file at Saint Louis University.
6. Samples are to remain in control of the individual who last signed for the samples, such as within eye-sight or stored in an appropriate secured location.

FRM 010

List of SOP's and Associated Forms, Expected Sample Numbers Per Residence, and Sample Type Codes

SOP No.	SOP's	Associated Forms	Form No.	Minimum Sample No.	Maximum Sample No.	Sample Indicator Code
	Soil					
500	- Away From House	Soil Collection	450	4	5	S
450	- Drip Line	Soil Collection	450	4	5	S
550	- Home Play Areas	Soil Collection	450	4	5	S
600	- Community Play Areas	Soil Collection	450	4	5	S
200	Dust Floor Vacuum	Floor Dust Vacuum Collection	200	4	5	V
		Home Schematic	100			
		Sampling Pump Calibration	210			
300	Vacuum Bag	Floor Dust Vacuum Bag Collection	300	0	1	B
150	Paint Chips	Paint Chip Collection	150	5	20	P
350	Drinking Water	Drinking Water Collection	350	0	1	W
250	Window Stool Dust Wipe	Dust Wipe Collection	250	4	5	D
		Home Schematic	100			
100	Indoor Environmental Assessment	Indoor Environmental Assessment	110	25	150	XRF
		XRF Calibration Check	120			
		XRF Use and Custody	130			
		Home Schematic	100			
400	Outdoor Environmental Assessm.	Outdoor Environmental Assessment	400	20	100	XRF
		XRF Calibration Check	120			
		XRF Use and Custody	130			
910		Chain of Custody	910			
210	Sampling Pump Calibration	Sampling Pump Calibration	210			
900	Field QA/QC Sampling	Field QA/QC Samples	900			
910	Sample Chain of Custody, Storage and Transport	Chain of Custody	400			
920	XRF Data Computer Download	XRF Download Logsheet	920			
			Totals	73	292	

07/30/95 Form 010

FRM 015

Check List of Items Each Sampling Team Should Have Available At Each Sampling Location

Check	Items Each Sampling Team Should Have Immediately Accessible	No.
	Residence file with all forms and ID labels (Should also always have extra forms)	1
	Writing board/clip board	1
	Pens/pencils and indelible markers	1 each
	Flashlight	1
	Calculator	1
	Paper Towels	2 rolls
	Baby wipes	2 boxes
	Utility knife	1
	Razor knife	1
	Bucket	1
	Bottle brush	1
	Alconox soap	1 container
	Distilled water and pouring container	1 container
	Framing square	1
	Measuring tapes small and large	1 each
	Gloves to wear when collecting all samples (latex or vinyl)	2 boxes
	Tweezers	1
	Sample collection bags 4-mil 8 x 8 (for cassettes, wipes and 1/2 inch soils)	2 boxes
	Sample collection bags 4-mil 12 x 15 (for vacuum bags and 6 inch soils)	2 boxes
	Small freezer zip-lock bags (for double bagging 1/2 inch soil samples)	2 boxes
	Large freezer zip-lock bags (for double bagging 6 inch soil samples, and combining all samples from residence)	2 boxes
	Soil coring tool	1
	Filter cassettes	1 box
	Drinking water collection containers (250 ml) supplied by lab	2
	500 ml container for measuring split water samples	1
	Small screwdriver for adjusting sampling pump as needed	1
	Tygon tubing cut to length with 45° on one end for vacuuming, and extra as needed	As needed
	Sampling pump (Calibrated to 2.5 L/minute)	1
	XRF Unit (Also case with transport information and calibration standards)	1
	Dosimetry rings to wear when using XRF	1
	Global Positioning System (GPS)	1

ID No. ________

FRM 020 - Check List and Quick Reference Sheet

Check	Performance Item	Location(s)	Specifications
	"Headquarters"		
	• Log Out XRF FRM 130		Wear Dosimeter for XRF Use
	• Calibrate Sampling Pump FRM 210		2.5 + or - 0.1 L.
	• Collect all necessary supplies		
	"Residence"		
	• Inform consent form	Check to see if in residence file!	Do not perform any sampling unless signed and in folder.
	• Release to physician	Check to see if in residence file!	Check and see if in folder - not required for sampling.
	• Consent for environmental sampling	Check to see if in residence file!	Do not perform any sampling unless signed and in folder.
	• Reimbursement form	Check to see if in residence file!	Check and see if in folder - not required for sampling.
	• Home Schematic FRM 100	All living areas	Indicate living spaces, other home information and GPS location
	• Indoor Environmental Assess. FRM 110	Child bdrm, up to 3 main play areas, and occupant main entrance	One form per room/area. Room information and painted surfaces with similar paint histories. Indicate all friction surfaces, surfaces < 3' from floor, surfaces > 3' from floor > 1 ft^2 in area.
	• XRF Calibration Check FRM 120		Complete form
	• Indoor XRF Measurments FRM 110	Child bdrm (#1), up to 3 main play areas (#1-4), and occupant main entrance (#5)	All friction surfaces including window sash, stool, trough, stop and casing, and door, jam and casing. If < 3' from floor - any damage or > than 1 ft^2. If > 3' from floor - any damage or > 10 ft^2.
	• Indoor Paint Chip Collection (only from damaged paint) FRM 150	Child bdrm, up to 3 main play areas, and occupant main entrance	If XRF > 0.7 and damaged. Or no XRF could be taken and > 10 ft^2 and damaged.
	• Window Stool Dust Wipe FRM 250	Child bdrm and up to 4 play areas	Operable windows only. All up to 5 and at least 1 from each room if possible
	• Floor Vacuum FRM 200	Child bdrm, main occupant entrance, and up to 3 main play areas	Check calibration. After child bdrm and entrance, priority to carpeted play areas. Limit minimum 4 and maximum 5 locations.
	• Vacuum Bag Collection FRM 300		Complete form.
	• Outdoor Environmental Assess. FRM 400	All walls and detatched areas	One form for each wall with similar paint history areas. One form for all detatched areas. Only 1st. floor. Indicate all friction surfaces, all surfaces > 10 ft^2 and any damaged surfaces bordering bare sil or hard surface play areas.
	• Outdoor XRF Measurments FRM 400	All walls and detatched areas	Only 1st. floor. All friction surfaces same as indoor. All surfaces > 10 ft^2, or damaged and bordering soil or hard surface play areas.
	• Outdoor Paint Chip Collection FRM 150	All walls and detatched areas	If XRF > 0.7 and damaged. Or no XRF could be taken and > 100 ft^2 and damaged.
	• Soil - Drip Line FRM 450	All wall areas	Limit composite of minimum 4 and maximum 5 samples.
	• Soil - Yard, non play area FRM 450	Divide yard into 4-5 areas	Limit composite of minimum 4 and maximum 5 samples.
	• Soil - Yard side-by-side 6" core FRM 450	Only perform in St. Francis County Homes	Take core sample within 6" of each of the Yard non-play area cores.
	• Soil - Play Area FRM 450		Limit composite of minimum 4 and maximum 5 samples.
	• Drinking Water FRM 350	Kitchen cold water faucet	Complete form.
	• Community Play Areas FRM 450	Selected near completion of study area residences	
	"Headquarters"		
	• XRF Calibration Check FRM 120		Complete form
	• Log in XRF FRM 130		Complete form
	• Sampe Pump Calib. Check FRM 210		Complete form
	• Sample Chain of Custody FRM 910		Complete form.
	• Sample Storage		
	• Sample Transport to Lab		Minimum once per five sampling days

07/30/95 Form 020

FRM 100
Home Schematic

Put ID Sticker
Here

On back side of form draw rough schematic floor plan of each floor which contains living space and label each room by its type. **Indicate "Study Childs Bedroom". Circle up to four primary play areas of study child.**

First Floor	Second Floor	Basement (If living or play space only)	Other ______

Is this (**Check One**)	___ Single family	___ 4 Units or less	___ 4 Units or more
Location is/has (Check One)	___ Basement	___ Slab	___Trailer
Total number of floors above ground _______.			
Total Number of Rooms in Residence _______.			

<u>Suggested room type names</u>

Study Child Bedroom (SBDR)	Bathrooms (BTR #)	Living Room (LR)	Dining Room (DR)
Other Bedrooms (BDR #)	Family Room (FR)	Play Room (PR)	Kitchen (K)
Breakfast Room (BRKR)	Nursery (NSRY)	Porch (P)	Hallways (H #)
Occupant Main Entrance (ME)			

Global Positioning System (performed at secured back yard location)

- Allow to operate for fifteen minutes prior to recording readings.

Latitude ______° ______.________ minutes

Longitude ______° ______.________ minutes

07/30/95

PAINTED SURFACES ONLY

Separate Page For Each Room - Draw Diagram On Reverse Side Of Sheet (Indicate North)

Put ID Sticker	WHERE SUPPLIED - [Write Highlighted Letter or Number in Space Provided]
Here	Date (MM/DD/YY) __/__/__ Inspector Initials (F/M/L) __/__/__ XRF No. ______ Page __ of __

Room No. ___ Room Type ___ (Dining room, Living room, Familyroom, Kitchen, Bedroom, Child's Bdrm, Hallway, BaThroom, Playroom, Nursery, Entry, PoRch, ClaSsroom, Other ____

Any visible paint chips present on the floor. (Circle One Yes / No) General condition (dustiness/debris) poor-1 to good-5 (Circle One) 1 2 3 4

Any visible paint chips present on the window stool. (Circle One Yes / No)

Does this room have: Check One ___ wall-to-wall carpet ___ piece carpet (dimensions __ X __) ___ no carpet

Room dimensions (ft) ___ X ___ Total No. Doors ___ Total No. Windows ___

Surface No.	Surface Type	Substrate Type	Damage Type	Damage Source	Total (sqft)	Height (ft) From Flr	Damaged (sqft)	XRF (mg/cm^2)	Buried Y or N	XRF Sample No.	Comments
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											

Surface No.	Surface Type	Substrate Type	Damage Type	Damage Source	General Comments
1.Wall Upper	14.Radiator	Wood	Chipping	Water	* Indicate 'Other' in space provided.
2.Wall Lower	15.Cabinets	Metal	Peeling	Gouge	** For window stools and other pertruding objects give indication of chew marks in comment column.
3.Wall	16.Baseboard	Plaster	Flaking	Aging/Use	
4.Door	17.Stair Treads	Dry Wall	CRacking	Scrape	
5.Door Casing	18.Stair Risers	MAsonry	Loose	Other*	
6.Door Jam	19.Furniture	Brick	None	None	
7.Window Sash	20.Pipes	Vinyl	Other*		
8.Window Casing	21.Handrail	TileCeramic			
9.Window trough	22.Post	Tile Plastic			
10.Window Stool	23.Floor	Other*			
11.Window Apron	24.Play Equipment	UnkNown			
12.Ceiling	25.Shelf				
	26.Other				

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11-46

FRM 120

XRF Calibration Check

Date (MM/DD/YY) __/__/__ Page ___ of ___.

XRF SN ____________________

Inspt. Initial	Time	Response Verification*	Source Check One (0.29 mg/cm^2)		Two (1.0 mg/cm^2)		Three (1.63 mg/cm^2)		Four-Back of Two		Action/Comments
			Sample No	Result	Sample No	Result	Sample No	Result	Sample No	Result	
			Average								
			Average								
			Average								
			Average								
			Average								
			Average								
			Average								

Perform all calibration checks on top of instrument case.

Perform each calibration check 20 seconds each for three trials, and average.

Perform calibration checks:

- Prior to use at each location.
- Instrument was knocked/dropped or other sudden impact.
- Instrument was turned off for one hour.

If any value is off be more than 20% from the average, then repeat test.

* Check if performed.

FRM 130
XRF Use and Custody

Manufacturer: Niton Model: XL Serial Number: ________ Page ___ of ___

Radionuclide: Cd 109 Source Activity New: Date - ________ 10 mCi Date due for wipe test ________

Date/Time Removed From Storage	Device Signed-Out by (Name)	Job Site Location of Use	Date/Time Returned to Storage	Device Returned by (Name)

07/30/95

FRM 150 - July 29, 1995

Paint Chip Collection

Put ID Sticker Here	Date (MM/DD/YY) _ _/_ _/_ _ Inspector Initials (F/M/L) _ _ _

	In/Out/ Detatched	Room No. or Wall letter	Surface No.	Comments/location
P-1				
P-2				
P-3				
P-4				
P-5				
P-6				
P-7				
P-8				
P-9				
P-10				
P-11				
P-12				
P-13				
P-14				
P-15				
P-16				
P-17				
P-18				
P-19				
P-20				
P-21				
P-22				
P-23				
P-24				
P-25				
P-26				
P-27				
P-28				
P-29				
P-30				
P-31				
P-32				

Put ID Sticker Here

Composite Sample Number V-_____
Date (MM/DD/YY) _ _/_ _/_ _
Inspector Initials (F/M/L) __/ __/ __

General Composite Description:

Location and Description for each composite (See Indoor Environmental Assessment Diagram):

1. Room number _ _ Floor type (carpet, wood, tile, linoleum, other __________)
General Comments:

Dimensions of vacuumed area (inches) _______X______. Calibration check Y N
Visible Soil/dust (**Circle One**) Y N
Surface very smooth (1) to very rough (5) **(Cirlce One)** 1 2 3 4 5

2. Room number _ _ Floor type (carpet, wood, tile, linoleum, other __________)
General Comments:

Dimensions of vacuumed area (inches) _______X______. Calibration check Y N
Visible Soil/dust (**Circle One**) Y N
Surface very smooth (1) to very rough (5) **(Cirlce One)** 1 2 3 4 5

3. Room number _ _ Floor type (carpet, wood, tile, linoleum, other __________)
General Comments:

Dimensions of vacuumed area (inches) _______X______. Calibration check Y N
Visible Soil/dust (**Circle One**) Y N
Surface very smooth (1) to very rough (5) **(Cirlce One)** 1 2 3 4 5

4. Room number _ _ Floor type (carpet, wood, tile, linoleum, other __________)
General Comments:

Dimensions of vacuumed area (inches) _______X______. Calibration check Y N
Visible Soil/dust (**Circle One**) Y N
Surface very smooth (1) to very rough (5) **(Cirlce One)** 1 2 3 4 5

5. Room number _ _ Floor type (carpet, wood, tile, linoleum, other __________)
General Comments:

Dimensions of vacuumed area (inches) _______X______. Calibration check Y N
Visible Soil/dust (**Circle One**) Y N
Surface very smooth (1) to very rough (5) **(Cirlce One)** 1 2 3 4 5

FRM 210
Sampling Pump Calibration Form

Page ___ of ___.

Calibration							Post Calibration check			
Date	Calibrator Name	Pump SN	Time	Flow Rate Average (L)*	Averaging Number	Rotometer Setting	Time	Calibrator Name	Flow Rate Check (L)*	Averaging Number

* Must be average of at least three measurements, preferably 10

Put ID Sticker Here

Composite Sample Number D-____ Date (MM/DD/YY) __/__/__

Inspector Initials (F/M/L) _ / _ / _

General Composite Description:

Location and Description for each composite (See Environmental Assessment Diagram):

1. Room number __ Surface number___ Comments:

Dimensions of wiped area (inches) _______X_______

Soiling Index (Circle Y or N)

Visible loose soil/dust	Y	N	First wipe - Visible soiling	Y	N
Visible Movement when blown	Y	N	Second wipe - Visible soiling	Y	N
			Third wipe - Visible soiling	Y	N

Smoothness of surface - very smooth (1) to very rough (5) 1 2 3 4 5

2. Room number __ Surface number___ Comments:

Dimensions of wiped area (inches) _______X_______

Soiling Index (Circle Y or N)

Visible loose soil/dust	Y	N	First wipe - Visible soiling	Y	N
Visible Movement when blown	Y	N	Second wipe - Visible soiling	Y	N
			Third wipe - Visible soiling	Y	N

Smoothness of surface - very smooth (1) to very rough (5) 1 2 3 4 5

3. Room number __ Surface number___ Comments:

Dimensions of wiped area (inches) _______X_______

Soiling Index (Circle Y or N)

Visible loose soil/dust	Y	N	First wipe - Visible soiling	Y	N
Visible Movement when blown	Y	N	Second wipe - Visible soiling	Y	N
			Third wipe - Visible soiling	Y	N

Smoothness of surface - very smooth (1) to very rough (5) 1 2 3 4 5

4. Room number __ Surface number___ Comments:

Dimensions of wiped area (inches) _______X_______

Soiling Index (Circle Y or N)

Visible loose soil/dust	Y	N	First wipe - Visible soiling	Y	N
Visible Movement when blown	Y	N	Second wipe - Visible soiling	Y	N
			Third wipe - Visible soiling	Y	N

Smoothness of surface - very smooth (1) to very rough (5) 1 2 3 4 5

5. Room number __ Surface number___ Comments:

Dimensions of wiped area (inches) _______X_______

Soiling Index (Circle Y or N)

Visible loose soil/dust	Y	N	First wipe - Visible soiling	Y	N
Visible Movement when blown	Y	N	Second wipe - Visible soiling	Y	N
			Third wipe - Visible soiling	Y	N

Smoothness of surface - very smooth (1) to very rough (5) 1 2 3 4 5

FRM 300

Floor Dust Vacuum Bag Collection

Put ID Sticker Here	Sample Number B - ___ Inspector Initials (F/M/L) __ / __ / __	Date (MM/DD/YY) __/__/__

Comments:

Brand ______________________________

Model ______________________________

Disposable Bag **(Circle One)** Y N

How full **(Circle One)** Full 3/4 1/2 Less than 1/2

If a sample could not be collected indicate reason below:

Refused by occupant ___

No vacuum present ___

Other ___________

07/30/95

FRM 350

Drinking Water Collection

Put ID Sticker Here	Sample Number W-__ Inspector Initials (F/M/L) __ / __ / __	Date (MM/DD/YY) _ _/_ _/_ _

Collection time (24 hour) _ _:_ _
Time since last used to closest half-hour _ _:_ _
Approximate collection volume (ml)? (Circle One) 1000 750 500 250 125 less
Location if other than kitchen:

General Comments:

FRM 400 - OUTDOOR ENVIRONMENTAL ASSESSMENT

PAINTED SURFACES ONLY

Separate Page For Each Side Of Structure - Draw Diagram On Reverse Side Of Sheet (Indicate North)

Put ID Sticker Here **WHERE SUPPLIED - [Write Highlighted Letter In Space Provided**

Date (MM/DD/YY) _ _/_ _/_ _ Inspector Initials (F/M/L) __ / __ / __ XRF NO. ________________ Page __ of __

Wall Letter: _ _ _ (Start with front entrance and go clockwise) **OR** **Check Here** ___ if detatched areas

Direction facing away from residence? **(Circle One** N NE E SE S SW W NW)

Any visible paint chips present on the ground? **(Circle One** Yes No) Total No. Doors _____ Total No. Windows _____

Surface No.	Surface Type	Substrate Type	Damage Type	Damage Source	Total (sqft)	Damage (sqft)	XRF (mg/cm^2)	Buried Y or N	XRF Sample No	Comments
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										
12.										
13.										
14.										

Surface Type		Substrate Type	Damage Type	Damage Source	General Comments:
1. Door	11. Rail	Wood	Chipping	Water	* Indicate "Other" in space provided.
2. Door Jam	12. Floor	Metal	Peeling	Gouge	
3. Door Casing	13. Under Floor	Siding	Flaking	Aging/Use	
4. Wall	14. Eave	MAsonry	CRacking	Scrape	
5. Stair Tread	15. Play Equip	Brick	Loose	WEather	
6. Stair Riser	16. Furniture	Other*	None	Other*	
7. Win Well	17. Structure	Not Known	Other*	None	
8. Win Casing					
9. Win Sash					
10. Post	20. Other*				

Draw Diagram on Reverse and Indicate North

For Each Separate Region Indicate Percent of Bare Ground to Vegetated Area or Other Covering in Space Provided

Put ID Sticker Here	Composite Sample Number S - ___ Inspector Initials (F/M/L) __ / __ / __	Date (MM/DD/YY) __ / __

Check One __ Drip Line __ Yard __ Home Play Area __ Community Play Area __ 6" _____ Other

General sample composite description:

1. Description:

Percent Bare Ground ____%. (For yard only)

Soil Condition (**CIRCLE THE APPROPRIATE OBSERVATION**)

Soil compact (1) or loose (5)	1	2	3	4	5
Soil easily broken (1) to difficult (5)	1	2	3	4	5
Soil wet (1) to dry (5)	1	2	3	4	5
Surface vegetated (1) to no vegetation (5)	1	2	3	4	5

Direction facing away from residence ___ Perpendicular distance from closest wall (ft) ___ Wall Letter ____

2. Description:

Percent Bare Ground ____%. (For yard only)

Soil Condition (**CIRCLE THE APPROPRIATE OBSERVATION**)

Soil compact (1) or loose (5)	1	2	3	4	5
Soil easily broken (1) to difficult (5)	1	2	3	4	5
Soil wet (1) to dry (5)	1	2	3	4	5
Surface covered completely (1) to no cover (5)	1	2	3	4	5

Direction facing away from residence ___ Perpendicular distance from closest wall (ft) ___ Wall Letter ____

3. Description:

Percent Bare Ground ____%. (For yard only)

Soil Condition (**CIRCLE THE APPROPRIATE OBSERVATION**)

Soil compact (1) or loose (5)	1	2	3	4	5
Soil easily broken (1) to difficult (5)	1	2	3	4	5
Soil wet (1) to dry (5)	1	2	3	4	5
Surface covered completely (1) to no cover (5)	1	2	3	4	5

Direction facing away from residence ___ Perpendicular distance from closest wall (ft) ___ Wall Letter ____

4. Description:

Percent Bare Ground ____%. (For yard only)

Soil Condition (**CIRCLE THE APPROPRIATE OBSERVATION**)

Soil compact (1) or loose (5)	1	2	3	4	5
Soil easily broken (1) to difficult (5)	1	2	3	4	5
Soil wet (1) to dry (5)	1	2	3	4	5
Surface covered completely (1) to no cover (5)	1	2	3	4	5

Direction facing away from residence ___ Perpendicular distance from closest wall (ft) ___ Wall Letter ____

5. Description:

Percent Bare Ground ____%. (For yard only)

Soil Condition (**CIRCLE THE APPROPRIATE OBSERVATION**)

Soil compact (1) or loose (5)	1	2	3	4	5
Soil easily broken (1) to difficult (5)	1	2	3	4	5
Soil wet (1) to dry (5)	1	2	3	4	5
Surface covered completely (1) to no cover (5)	1	2	3	4	5

Direction facing away from residence ___ Perpendicular distance from closest wall (ft) ___ Wall Letter ____

* **The site area description should include such aspects as soil, foliage, presence of vegetable garden, area boundary, fencing, animal activities, surroundings outside of boundary, other affecting factors. Show all buildings, walkways, exposed soil spots, rain spouts runoff, approximate dimensions and relative position of all sample locations. Approximate location of sample and distance from structures and boundaries should be indicated.**

07/30/95

FRM 910
CHAIN OF CUSTODY RECORD
(One Sheet for Each Residence)

Page ___ of ___.

Date __/__/__

Put ID Sticker Here	Big River Study #95-59 Saint Louis University School of Public Health 3663 Lindell Blvd St. Louis, MO 63108	Contact: David Sterling, Ph.D., CIH (314) 977-8123 (W) (314) 977-8150 (F) sterling@sluvca.slu.edu

	Sample Number	Laboratory Number	Date Collected	Sample Area (inches) ___ X___ or Core Depth	Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

	Signature	Company	Date/Time	Comments
Relinquished By:				
Recieved By:				
Relinquished By:				
Recieved By:				
Relinquished By:				
Recieved By:				

Prefix before sample number indicates matrix type: P-Paint chip, W-Drinking Water with nitric acid preservative (supplied by lab), V- Hand vacuum with 0.8u MCE filter for dust/soil, B- Vacuum bag with dust/soil sample, S- Soil sample, D- Wipe sample to include dimensions of area tested.

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FRM 920

XRF Computer Download Log

Page ___ of ___

Technician Name	XRF No.	Disk No(s)	File Names	Date Downloaded	Total Sample Number	Comments
			.XL			
			.XLK			
			.XLL			
			.XL			
			.XLK			
			.XLL			
			.XL			
			.XLK			
			.XLL			
			.XL			
			.XLK			
			.XLL			
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			.XL			
			.XLK			
			.XLL			
			.XL			
			.XLK			
			.XLL			
			.XL			
			.XLK			
			.XLL			

08/10/95

Appendix 12: Environmental Laboratory Certifications

ENVIRONMENTAL LABORATORY CERTIFICATIONS

Primary Laboratory	Secondary Laboratory
• American Industrial Hygiene Association (AIHA) ⇒ Accreditation No. 441 • Environmental Lead Proficiency Analytical Testing (ELPAT)Laboratory ⇒ Identification No. 8950 • Commonwealth of Virginia, Department of General Services, Consolidated Laboratory Services State Drinking Water Analysis ⇒ Identification No. 00333	• American Association for Laboratory Accreditation (AALA) ⇒ Certificate No. 0597-01

Appendix 13: Laboratory Methodologies For Environmental Lead Analysis

LABORATORY METHODOLOGIES FOR ENVIRONMENTAL LEAD ANALYSIS

Sample Type	Primary Laboratory	Secondary Laboratory
Dust Wipe	EPA SW-846, includes 3050 acid digestion of sediments, sludge's and soils. Lead by method 742	NA
Vacuum Cassette Filter	EPA SW-846, includes 3050 acid digestion of sediments, sludge's and soils. Lead by method 742. Gravimetric analysis for filter mass using matched weight filter cassettes.	NA
Soi/Vacuum Bag Dust	EPA SW-846, includes 3050 acid digestion of sediments, sludge's and soils. Lead by method 742.	EPA SW846, includes 3050 acid digestion of sediments, sludges and soils, followed by inductively coupled argon plasma (ICP) analysis using a modified SW-846 Method 6010A
Drinking Water	EPA Method 239.2, EPA 600 series, with graphite furnace atomic absorption (GFAA) analysis	Modified EPA SW-846 Method 7421, with graphite furnace atomic absorption (GFAA) analysis

NA - Not applicable. These sample analysis were not performed by the secondary laboratory.

Appendix 14: Laboratory Detection and Quantification Limits for Environmental Samples

LABORATORY DETECTION AND QUANTIFICATION LIMITS FOR ENVIRONMENTAL SAMPLES

Media and Analyte	Instrument Quantification Limit (IQL) (mg/L)	Instrument Detection Limit (IDL) (mg/L)	Digestion Volume (ml)	Practical Quantification Limit (PQL)	Method Detection Limit (MDL)
Soil (ug/g), Dust Wipes (ug) and Vacuum bags (ug/g)			50		
• lead	0.50	0.0419		25.0	2.5
Drinking Water (ug/L)	NA	NA	NA		
• lead				5.0	0.264
Vacuum Cassette Filters (ug)			25		
• lead	0.10	0.0419		2.5	1.24
• gravametric analysis for filters	--	--	--	0.1 mg	

NA - Not applicable.

Appendix 15: Laboratory Quality Control Procedures

LABORATORY QUALITY CONTROL PROCEDURES

QC Procedure	Frequency	Criteria
Initial Calibration	Once per analysis run	None
High Standard Verification	Immediately after initial calibration	95 to 105% of actual concentration
Initial Calibration Verification	Immediately after high standard verification	90 to 110% of actual concentration
Continuing Calibration Verification	Every 10 samples and at the end of the run	90 to 110% of actual concentration
Continuing Blank Verification	Every 10 samples and at the end of the run	Less than detection limit
Interference Check Standard	Beginning and end run plus every 8 hours	80 to 120% of actual concentration
High Sample Results	For every analyte over high standard response	Dilute the sample within the calibration range

Appendix 16: Nist Standard Reference Materials used for Spikes

NIST STANDARD REFERENCE MATERIALS USED FOR SPIKES

Sample Type	Standard Reference Material (SRM)
Wipe	NIST Lead Paint Dust Standard Powdered Lead Based Paint SRM 1579a
Vacuum Cassette Filter	NIST Standard Urban Particulate Standard SRM 1648
Soil	NIST Standard Montana II Soil SRM 2711
Water	NIST Trace Metals in Water Standard SRM 1643d

Appendix 17: Intended and Achieved Frequency of Environmental Sample Quality Control

INTENDED AND ACHIEVED FREQUENCY OF ENVIRONMENTAL SAMPLE QUALITY CONTROL

Quality Control Type	Dust Wipe	Vacuum Bag	Soil	Vacuum Cassette	Drinking Water	Latex Gloves	Collection bags
SRM		NA				NA	NA
• Intended	2%		2.5%	20%	2.5%		
• Achieved	1.9%		2.4%	20%	2.3%		
Field Blanks[1]		NA	NA		NA		
• Intended	1/day/field team			1/day/field team		2.5%	2.5%
• Achieved	1/day/field team			1/day/field team		1%	1.3%
Side-By-Side	NA	NA		NA	NA	NA	NA
• Intended			5%				
• Achieved			5.1%				
Split	NA			NA		NA	NA
• Intended		5%	5%		5%		
• Achieved		5.3%	5.3%		5.9%		

NA - Not applicable. This type of quality control was not performed.

[1] Field blanks for dust wipes and vacuum filter cassettes were obtained on a daily basis for each field team.